ATA MSG-3

Operator/Manufacturer Scheduled Maintenance Development

Revision 2003.1

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Highlights

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Location	Description of Change
	See the Preface section for a complete description.

Preface

Airline and manufacturer experience in developing scheduled maintenance for new aircraft has shown that more efficient programs can be developed through the use of logical decision processes.

In July, 1968, representatives of various airlines developed Handbook MSG-1, "Maintenance Evaluation and Program Development," which included decision logic and inter-airline/manufacturer procedures for developing scheduled maintenance for the new Boeing 747 aircraft.

Subsequently, it was decided that experience gained on this project should be applied to update the decision logic and to delete certain 747 detailed procedural information so that a universal document could be made applicable for later new type aircraft. This was done and resulted in the document, entitled, "Airline/ Manufacturer Maintenance Program Planning Document," MSG-2. MSG-2 decision logic was used to develop scheduled maintenance for the aircraft of the 1970's.

In 1979, a decade after the publication of MSG-2, experience and events indicated that an update of MSG procedures was both timely and opportune in order for the document to be used to develop maintenance for new aircraft, systems or powerplants.

An ATA Task Force reviewed MSG-2 and identified various areas that were likely candidates for improvement. Some of these areas were the rigor of the decision logic, the clarity of the distinction between economics and safety, and the adequacy of treatment of hidden functional failures. Additionally

A. The development of new generation aircraft provided a focus, as well as motivation, for an evolutionary advancement in the development of the MSG concept.

B. New regulations which had an effect on maintenance programs had been adopted and therefore needed to be reflected in MSG procedures. Among those were new damage tolerance rules for structures and the Supplemental Structural Inspection program for high time aircraft.

C. The high price of fuel and the increasing cost of materials created trade-off evaluations which had great influences on maintenance program development. As a result, maintenance programs required careful analysis to ensure that only those tasks were selected which provided genuine retention of the inherent designed level of safety and reliability, or provided economic benefit.

MSG-3, Original Revision

Against this background, ATA airlines decided that a revision to existing MSG-2 procedures was both timely and appropriate. The active participation and combined efforts of the FAA, CAA/UK, AEA, U.S. and European aircraft and engine manufacturers, U.S. and foreign airlines, and the U.S. Navy generated the document, MSG-3. As a result there were a number of differences between MSG-2 and MSG-3, which appeared both in the organization/presentation of the material and in the detailed procedural content. However, MSG-3 did not constitute a fundamental departure from the previous version, but was built upon the existing framework of MSG-2 which had been validated by ten years of reliable aircraft operation using maintenance based thereon.

The following reflects some of the major improvements and enhancements generated by MSG-3 as compared to MSG-2.

1. Systems/Powerplant Treatment:

   MSG-3 adjusted the decision logic flow paths to provide a more rational procedure for task definition and a more straightforward and linear progression through the decision logic.

   MSG-3 logic took a "from the top down" or consequence of failure approach. At the outset, the functional failure was assessed for consequence of failure and was assigned one of two basic categories:

   A. SAFETY

   B. ECONOMIC

   Further classification determined sub-categories based on whether the failure was evident to or hidden from the operating crew. (For structures, category designation was "significant" or "other" structure, and all functional failures were considered safety consequence items).

   With the consequence category established for systems/powerplants, only those task selection questions pertinent to the category needed to be asked. This eliminated unnecessary assessments and expedited the analysis. A definite applicability and effectiveness criteria was developed to provide more rigorous selection of tasks. In addition, this approach helped to eliminate items from the analytical procedure whose failures had no significant consequence.

   Task selection questions were arranged in a sequence such that the most preferred, most easily accomplished task, was considered first. In the absence of a positive indication concerning the applicability and effectiveness of a task, the next task in sequence was considered, down to and including possible redesign.

2. Structures Treatment:

   Structures logic evolved into a form which more directly assessed the possibility of structural deterioration processes. Considerations of fatigue, corrosion, accidental damage, age exploration and others, were incorporated into the logic diagram and were routinely considered.

3. MSG-3 recognized the new damage tolerance rules and the supplemental inspection programs, and provided a method by which their intent could be adapted to the **Maintenance Review Board (MRB)** process instead of relying on type data certificate restraints. Concepts such as multiple failures, effect of failure on adjacent structure, crack growth from detectable to critical length, and threshold exploration for potential failure, were covered in the decision logic of the procedural material.

4. The MSG-3 logic was task-oriented and not maintenance process oriented (MSG-2). This eliminated the confusion associated with the various interpretations of **Condition Monitoring (CM)**, **On-Condition (OC)**, **Hardtime (HT)** and the difficulties encountered when attempting to determine what maintenance was being accomplished on an item that carried one of the process labels.

   By using the task-oriented concept, one would be able to view the MRB document and see the initial scheduled maintenance reflected for a given item (e.g., an item might show a lubrication task at the "A" frequency, and inspection/functional check at the "C" frequency and a restoration task at the "D" frequency).

5. Servicing/Lubrication was included as part of the logic diagram to ensure that this important category of task was considered each time an item was analyzed.

6. The selection of maintenance tasks, as output from the decision logic, was enhanced by a

clearer and more specific delineation of the task possibilities contained in the logic.

7. The logic provided a distinct separation between tasks applicable to either hidden or evident functional failures; therefore, treatment of hidden functional failures was more thorough than that of MSG-2.

8. The effect of concurrent or multiple failure was considered. Sequential failure concepts were used as part of the hidden functional failure assessment (Systems/Powerplant), and multiple failure was considered in structural evaluation (Structures).

9. There was a clear separation between tasks that were economically desirable and those that were required for safe operation.

10. The structures decision logic no longer contained a specific numerical rating system. The responsibility for developing rating systems was assigned to the appropriate manufacturer with approval of the Industry Steering Committee.

MSG-3, Revision 1

In 1987, after using MSG-3 procedures on a number of new aircraft and powerplants in the first half of the 1980's, it was decided that the benefits of the experience so gained should be used to improve the document for future application; thus, Revision 1 was undertaken.

This revised document includes changes developed by American and European airframe manufacturers, American and European airworthiness authorities, supplemented and agreed to by the Air Transport Association of America and other airline representatives.

The major improvements and enhancements reflected in items one through nine above were basically unchanged and remain applicable to this revised document.

The following are some of the more noteworthy revisions that have been incorporated:

1. Table of Contents and a List of Effective Pages: ADDED.

2. Clarification that MSG-3 is used to develop an "initial scheduled maintenance program."

3. The task - "Operating Crew Monitoring": DELETED.

4. Section addressing "Threshold Sample": REVISED.

5. Section addressing "Program Development Administration": DELETED.

6. "Top-down approach" - explanation of process: ADDED.

7. "Visual Check" added to "Operational Check" task.

8. System/Powerplant and Structures logic diagrams: REVISED.

9. Task selection criteria table: ADDED.

10. Inspections:

    Detailed Inspection - REVISED.

    Directed Inspection - DELETED.

    External Surveillance Inspection - DELETED.

General Visual Inspection - REVISED.

Internal Surveillance Inspection - DELETED.

Special Detailed Inspection - UNCHANGED.

Walk Around Check Inspection - DELETED.

11. Clarification of hidden functional failure: "one additional failure."
12. Inspection/Functional Check task question revised.
13. Reference to a "User's Guide" for procedures related to administration and forms added.
14. Reference to "off-aircraft" deleted.
15. Operating Crew Normal Duties - "Normal Duties" revised to delete pre-flight and post-flight check list; added "on a daily basis" for frequency of usage with respect to normal crew duties.
16. Added that procedures for handling composite of other new materials may have to be developed.
17. Reference to specific U.S. Federal Air Regulations: DELETED.
18. Definition of "Operating": REVISED.
19. Defined logic for failures which may affect dispatch capability or involve the use of abnormal or emergency procedures. Failure-effect Category 6 is now identified as "Operational - Evident".
20. Noted that each MSI and SSI should be recorded for tracking purposes whether or not a task was derived therefrom.

MSG-3, Revision 2

In 1993, MSG-3 Revision 2 was incorporated. The most significant changes introduced were:

1. To adapt MSG-3 logic procedures to assure development of tasks/intervals associated with the aircraft's certificated operating capabilities.
2. To provide guidelines which ensure that a consistent approach be taken with respect to tasks/intervals required to maintain compliance with Type Certification requirements.
3. To provide guidelines on the development of Corrosion Prevention and Control Programs.
4. To introduce procedures to determine the appropriate scheduled maintenance requirements for composite structure.
5. To revise inspection task definitions.

MSG-3 [Section 2-4] and its respective logic diagrams have been revised to add an evaluation process to insure the **Corrosion Prevention and Control Program (CPCP)** is considered in the evaluation of each **Structural Significant Item (SSI)** and every zone.

Damage Sources [Heading 2-4-3.1] now includes a discussion of non-metallic materials (composites).

Procedures [Heading 2-4-4.1] has been revised to add Procedure and Decision blocks for the CPCP evaluation and edited to produce a more ordered flow of the Procedure and Decision block numbers.

The Glossary - [Appendix A] Inspection Level Definitions have been revised to apply to Systems, Powerplants and Structures, and definitions related to CPCP have been added.

It is suggested, in order to fully comprehend the MSG-3 concept, that the entire MSG-3 document be reviewed and considered prior to accepting or modifying its approaches to maintenance development. A User's Guide or Policies and Procedures Handbook may be adopted with guidance and approval of the Industry Steering Committee.

MSG-3, Revision 2001

In 2001, MSG-3 Revision 2001 was incorporated. The most significant changes introduced were:

1. Added distance requirement and use of a mirror to definition of General Visual Inspection (GVI).
2. Deleted "visual" from definition of Detailed Inspection, and substituted the term "used" for the word "necessary."
3. Corrected terminology throughout the document to change the product of MSG-3 from a "maintenance program" to simply "maintenance."
4. Guidance was added to [Heading 2-3-5.1]. to cover acceptable assumptions as to the flight crew "normal duties" in determining whether or not a functional failure is evident.
5. Expanded the wording on hidden functions of safety/emergency systems or equipment [Heading 2-3-5.3].
6. Deletion of the requirement to forward FEC 6 items without task to the ISC/MRB for review..
7. Significantly expanded the wording on "Interval Determination" [Subject 2-3-8].
8. Rewrote [Section 2-5] to incorporate enhanced zonal analysis.
9. Added a section [Section 2-6] on analysis for Lightning/High Intensity Radiated Field (L/HIRF).
10. Added many more terms to the Glossary.

MSG-3, Revision 2002

In 2002, MSG-3 Revision 2002 was incorporated. The most significant changes introduced were:

1. Added wording emphasizing the importance of recording any and all assumptions made during analysis.
2. Added wording emphasizing the importance of fully considering all available Vendor Recommendations during MWG discussions.
3. Rewrote the MSI Selection Process to expand and clarify.
4. Added a new Subject 2-3-2., "Analysis Procedure" in order to separate its paragraphs from the MSI Selection Process.
5. Procedure added for Fault-Tolerant Systems Analysis.
6. Explanation provided for use of MMEL in answering Systems Analysis Level 1 Question 4.
7. General Visual Inspection (GVI) definition was clarified.

8. Structural Maintenance Task Development expanded to address analysis of non-metallic structures.

9. Glossary additions - "Fault" and "Redundant Functional Elements."

MSG-3, Revision 2003

In 2003, MSG-3 Revision 2003 was incorporated. The most significant changes introduced were:

1. Added 3-letter task abbreviations to the 2-letter task abbreviations of Section 2-1-2.2.

2. Rewrote the procedural Section 2-3-4. for "Fault-Tolerant Systems"as per FAA request.

3. Added a definition for "Fault-Tolerant System" to the Appendix A, Glossary.

4. Divided existing definition in Appendix A, Glossary, for "Safety/Emergency Systems or Equipment" into bullet points to clarify.

Chapter 1. General

1-1. Objective

It is the objective of this document to present a means for developing the scheduled maintenance tasks and intervals which will be acceptable to the regulatory authorities, the operators, and the manufacturers. The scheduled maintenance task and interval details will be developed by coordination with specialists from the operators, manufacturers, and the Regulatory Authority of the country of manufacture. Specifically, this document outlines the general organization and decision processes for determining scheduled maintenance requirements initially projected for the life of the aircraft and/or powerplant.

Historically, the initial scheduled maintenance tasks and intervals have been specified in **Maintenance Review Board (MRB)** Reports. MSG-3 is intended to facilitate the development of initial scheduled maintenance. The remaining maintenance, that is, non-scheduled or non-routine maintenance, consists of maintenance actions to correct discrepancies noted during scheduled maintenance tasks, other non-scheduled maintenance, normal operation, or data analysis.

This document addresses the development of scheduled maintenance using the MSG-3 analysis procedure. Any additional requirements developed, using different ground rules and procedures from MSG-3, must be submitted with selection criteria to the Industry Steering Committee for consideration and inclusion in the MRB Report recommendation.

1-2. Scope

For the purpose of developing an MRB report, MSG-3 is to be used to determine initial scheduled maintenance requirements. The analysis process identifies all scheduled tasks and intervals based on the aircraft's certificated operating capabilities.

1-3. Organization

The organization to carry out the scheduled maintenance development for a specific type aircraft shall be staffed by representatives of the airline operators purchasing the equipment, the prime manufacturers of the airframe and powerplant, and the Regulatory Authority.

1-3-1. Industry Steering Committee

The management of the scheduled maintenance development activities shall be accomplished by an **Industry Steering Committee** composed of members from a representative number of operators and representatives of the prime airframe and engine manufacturers. It shall be the responsibility of this committee to establish policy, set initial goals for scheduled maintenance check intervals, direct the activities of working groups or other working activity, carry out liaison with the manufacturer and other operators, prepare the final recommendations and represent the operators in contacts with the Regulatory Authority. The ISC should see that the MSG-3 process identifies 100% accountability for all **Maintenance Significant Items (MSI's)** and **Structural Significant Items (SSI's)**, whether or not a task has been derived from the analysis.

The ISC should advise Maintenance Working Groups (MWG) to fully consider available Vendor Requirements (VR), and accept them only if they are applicable and effective according to MSG-3 criteria.

1-3-2. Working Groups

One or more Working Groups, consisting of specialist representatives from the participating operators, the prime manufacturer, and the Regulatory Authority, may be constituted. The Industry Steering Committee, alternatively, may arrange some other means for obtaining the detailed technical information necessary to develop recommendations for scheduled maintenance in each area. Irrespective of the organization of the working activity, written technical data must be provided that supports its recommendations to the Industry Steering Committee. After approval by the Industry Steering Committee, these analyses and recommendations shall be consolidated into a final report for presentation to the Regulatory Authority.

Chapter 2. Development of Scheduled Maintenance

2-1. General

It is necessary to develop scheduled maintenance for each new type of aircraft prior to its introduction into airline service.

2-1-1. Purpose

The primary purpose of this document is to develop a proposal to assist the Regulatory Authority in establishing initial scheduled maintenance tasks and intervals for new types of aircraft and/or powerplant. The intent is to maintain the inherent safety and reliability levels of the aircraft. These tasks and intervals become the basis for the first issue of each airline's maintenance requirements to govern its initial maintenance policy. Initial adjustments may be necessary to address operational and/or environmental conditions unique to the operator. As operating experience is accumulated, additional adjustments may be made by the operator to maintain efficient scheduled maintenance.

2-1-2. Approach

It is desirable, therefore, to define in some detail

a) The objectives of efficient scheduled maintenance.

b) The content of efficient scheduled maintenance.

c) The method by which efficient scheduled maintenance can be developed.

1. Scheduled Maintenance Objectives

The objectives of efficient aircraft scheduled maintenance are

a) To ensure realization of the inherent safety and reliability levels of the aircraft.

b) To restore safety and reliability to their inherent levels when deterioration has occurred.

c) To obtain the information necessary for design improvement of those items whose inherent reliability proves inadequate.

d) To accomplish these goals at a minimum total cost, including maintenance costs and the costs of resulting failures.

These objectives recognize that scheduled maintenance, as such, cannot correct deficiencies in the inherent safety and reliability levels of the aircraft. The scheduled maintenance can only prevent deterioration of such inherent levels. If the inherent levels are found to be unsatisfactory, design modification is necessary to obtain improvement.

2. Scheduled Maintenance Content

The content of the scheduled maintenance itself consists of two groups of tasks

a) A group of scheduled tasks to be accomplished at specified intervals. The objective of these tasks is to prevent deterioration of the inherent safety and reliability levels of the aircraft. The tasks in scheduled maintenance may include:

(1) Lubrication/Servicing (LU/SV or LUB/SVC)

(2) Operational/Visual Check (OP/VC or OPC/VCK)

(3) Inspection/Functional Check (IN*/FC or */FNC)

* General Visual Inspection (GV or GVI)

* Detailed Inspection (DI or DET)

* Special Detailed Inspection (SI or SDI)

(4) Restoration (RS or RST)

(5) Discard (DS or DIS)

and

b) A group of non-scheduled tasks which result from:

(1) The scheduled tasks accomplished at specified intervals.

(2) Reports of malfunctions (usually originated by the operating crew).

(3) Data analysis.

The objective of these non-scheduled tasks is to restore the aircraft to an acceptable condition.

An efficient program is one which schedules only those tasks necessary to meet the stated objectives. It does not schedule additional tasks which will increase maintenance costs without a corresponding increase in reliability protection.

3. Method for Scheduled Maintenance Development

This document describes the method for developing the scheduled maintenance . Non-scheduled maintenance results from scheduled tasks, normal operation or data analysis.

Scheduled maintenance will be developed via use of a guided logic approach and will result in a task-oriented program. The logic's flow of analysis is failure-effect oriented.

Items that, after analysis, have no scheduled task specified, may be monitored by an operator's reliability program.

Assumptions made during the analysis, that can result in a change to the analysis, are to be recorded.

- ❖ Assumptions applying to the program as a whole, and not only to an individual MSG-3 analysis, are to be documented in the appropriate "Policy and Procedures Handbook" or "User's Guide." As a minimum, this applies to statements concerning anticipated average annual utilization, the environments to be considered, and the operating capabilities to which the aircraft/powerplant is certificated.

- If an analysis is (partially or as a whole) based on design solutions not completely frozen, this should be recorded in the analysis.

2-2. Divisions of MSG-3 Document

The working portions of MSG-3 are contained in the next four (4) sections. Systems/Powerplant, including components and APU's, are considered in [Section 2-3]. Aircraft Structures is considered in [Section 2-4], Zonal Inspections in [Section 2-5] and L/HIRF is considered in [Section 2-6]. Each section contains its own explanatory material and decision logic diagram (as appropriate); therefore, it may be used independently of other MSG-3 sections.

Figure 2-2.1. Systems Powerplant Logic Diagram (Part 1 of 2)

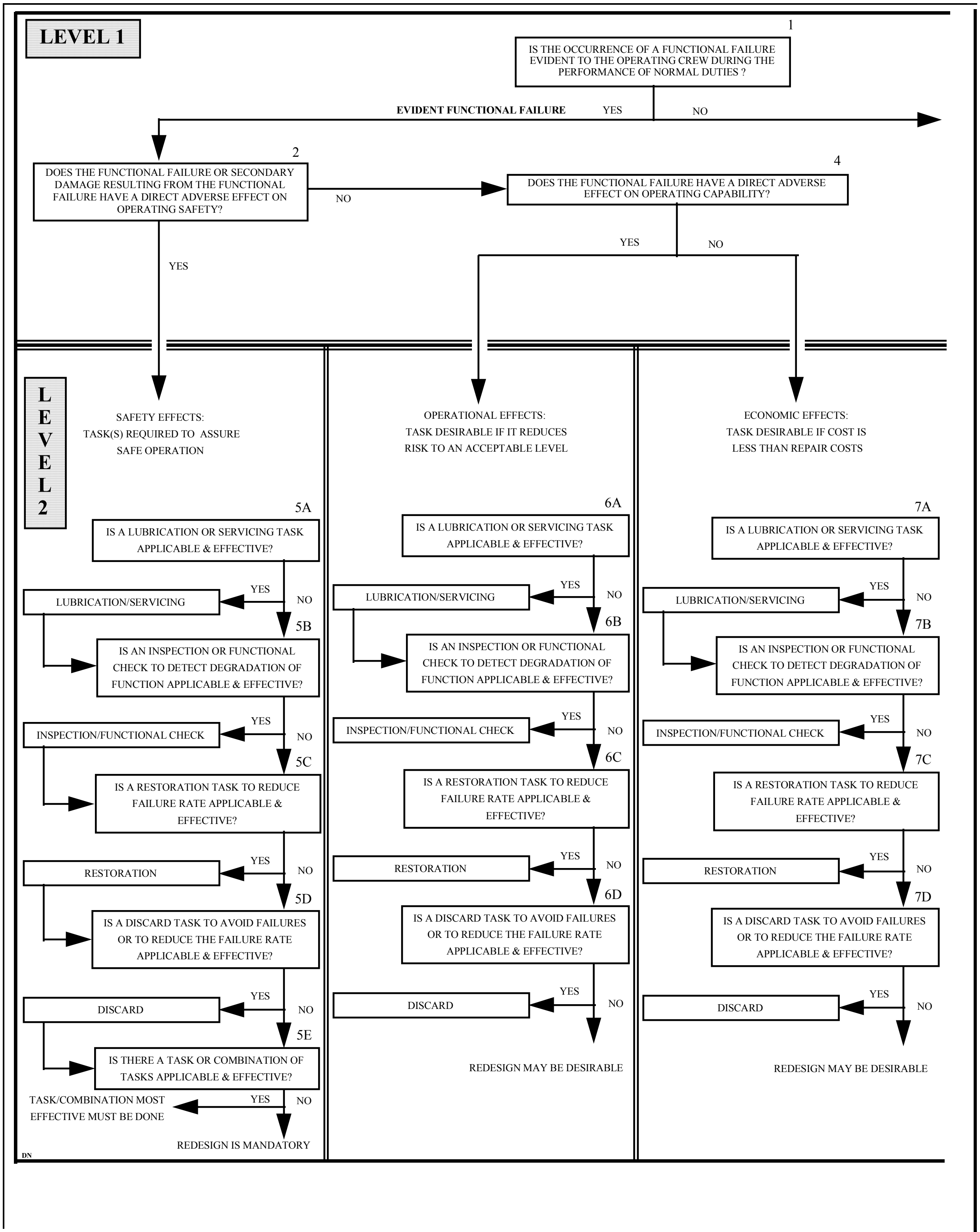
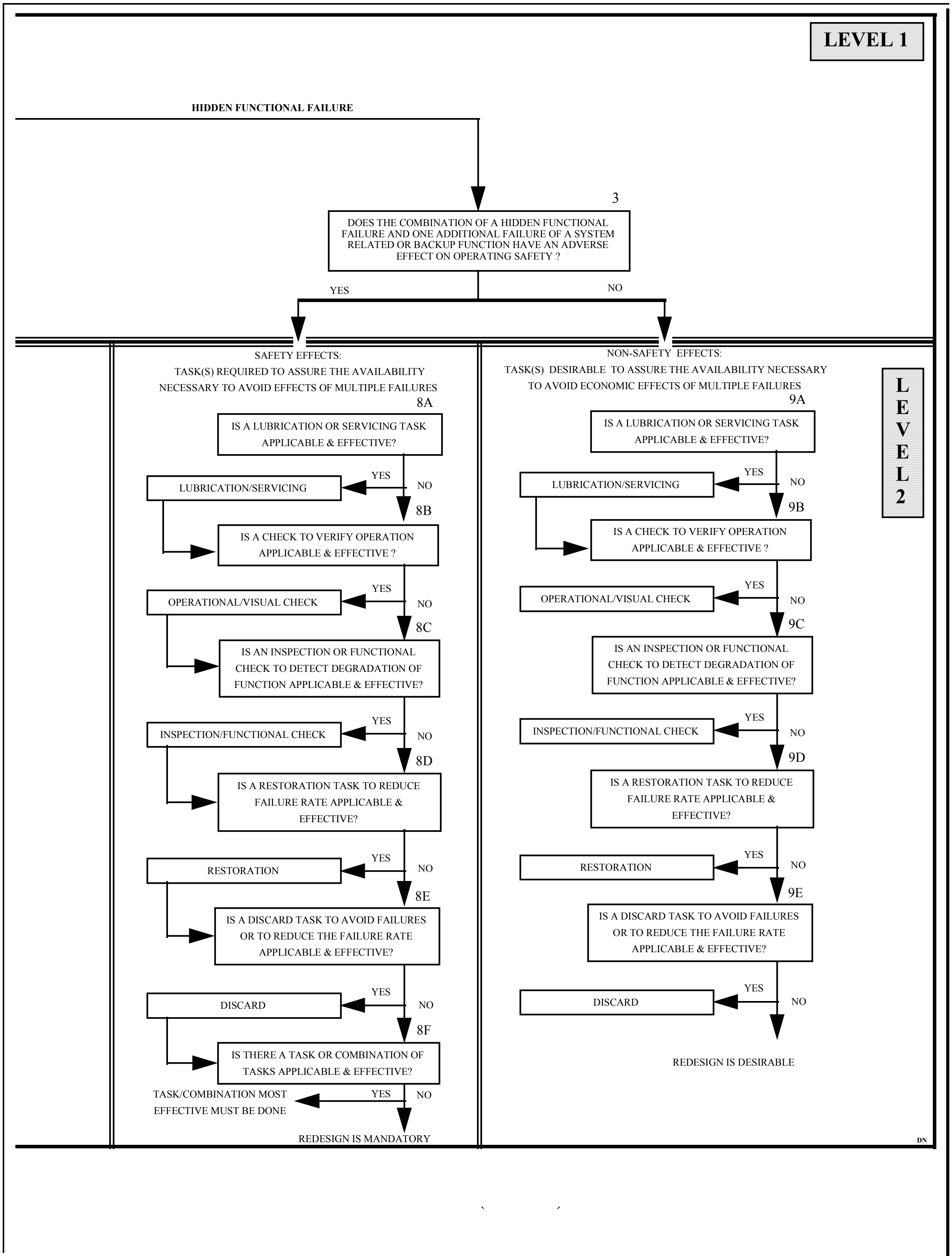


Figure 2-2.1. Systems Powerplant Logic Diagram (Part 2 of 2)



2-3. Aircraft Systems/Powerplant Analysis Procedure

The method for determining the scheduled maintenance tasks and intervals for systems/powerplant, including components and APU's, uses a progressive logic diagram. A glossary of terms and definitions used in the logic diagram is listed in Appendix A. This logic is the basis of an evaluation technique applied to each maintenance significant item (system, sub-system, module, component, accessory, unit, part, etc.), using the technical data available. Principally, the evaluations are based on the item's functional failures and failure causes.

2-3-1. MSI Selection

Before the actual MSG-3 logic can be applied to an item, the aircraft's significant systems and components must be identified.

Maintenance Significant Items (MSIs) are items fulfilling defined selection criteria (see Step 3., below) for which MSI analyses are established at the highest manageable level.

This process of identifying Maintenance Significant Items is a conservative process (using engineering judgment) based on the anticipated consequences of failure. The top-down approach is a process of identifying the significant items on the aircraft at the highest manageable level.

The MSI selection process is outlined below:

1. Step 1.

The manufacturer partitions the aircraft into major functional areas; ATA Systems and Subsystems. This process continues until all on-aircraft replaceable components have been identified.

NOTE:	Items within the Structural ATA Chapters (51-57) that lend themselves to System analysis (e.g., fuselage drains, door mechanisms, etc.) should be included in this step. In addition, all safety/emergency systems or equipment should also be included.

2. Step 2.

Using a top-down approach, the manufacturer establishes the list of items to which the MSI selection questions will be applied.

3. Step 3

The manufacturer applies the following questions to the list of items identified in Step 2:

a) Could failure be undetectable or not likely to be detected by the operating crew during normal duties?

b) Could failure affect safety (on ground or in flight), including safety/emergency systems or equipment?

c) Could failure have significant operational impact?

d) Could failure have significant economic impact?

4. Step 4

a) For those items for which at least one of the four questions is answered with a "YES," MSG-3 analysis is required, and the highest manageable level must be confirmed (see Step 2, above). Consideration should be given to selecting a higher manageable level that includes this item as part of that higher-level system.

An MSI is usually a system or sub-system, and is, in most cases, one level above the lowest (on-aircraft) level identified in Step 1. This level is considered the highest manageable level; i.e., one which is high enough to avoid unnecessary analysis, but low enough to be properly analyzed and ensure that all functions, functional failures and failure causes are covered.

b) For those items for which all four questions are answered with a "NO," MSG-3 analysis is not required and further MSI selection analysis is not necessary at lower levels. Additionally, the lower-level items should be listed to identify those that will not be further assessed. This list must be presented by the manufacturer to the ISC for review and approval.

5. Step 5

Once the highest manageable level is confirmed per Step 4, the resulting list of items is now considered the "Candidate MSI List," and is presented by the manufacturer to the ISC. The ISC, in turn, reviews and approves this list for subsequent distribution to the Working Groups.

6. Step 6

The Working Groups will review the Candidate MSI List, and through application of MSG-3 analysis, validate the selected highest manageable level or (if required) propose modification of the MSI list to the ISC. The primary aim of the Working Group review is to verify that no significant item has been overlooked, and that the right level for the analysis has been chosen.

NOTE:	Although an item may be selected as an MSI and will be analyzed, this does not imply that a task will necessarily result from the analysis.

2-3-2. Analysis Procedure

After the MSI's have been selected, the following must be identified for each MSI:

a) Function(s) - the normal characteristic actions of an item

b) Functional Failure(s) - Failure of an item to perform its intended function within specified limits

c) Failure Effect(s) - what is the result of a functional failure

d) Failure Cause(s) - why the functional failure occurs

Defining some functional failures may require a detailed understanding of the system and its design principles. For example, for system components having single element dual load path features, such as concentric tubes or back-to-back plates, the function of both paths should be analyzed individually.

The degradation and/or failure of one path may not be evident.

When listing functions, functional failures, failure effects, and failure causes, care should be taken to identify the functions of all protective devices. These include devices with the following functions:

a) to draw the attention of the operating crew to abnormal conditions

b) to shut down equipment in the event of a failure

c) to eliminate or relieve abnormal conditions which follow a failure

d) to take over from a function that has failed

Protective function statements should describe the protective function itself, and should also include the words "if" or "in the event of" followed by a brief description of the events or circumstances that would activate or require activation of the protection. For example, "To open the relief valve to atmosphere in the event of system X pressure exceeding 300 psi."

Tasks and intervals required in the scheduled maintenance are identified using the procedures set forth herein. Both the economic and safety related tasks are included so as to produce initial scheduled maintenance tasks/intervals.

All available Vendor Recommendations (VR) should be fully considered, discussed in the MWG meetings, and accepted only if they are applicable and effective according to MSG-3 criteria.

Prior to applying the MSG-3 logic diagram to an item, a preliminary work sheet will be completed that clearly defines the MSI, its function(s), functional failure(s), failure effect(s), failure cause(s) and any additional data pertinent to the item; e.g., ATA chapter reference, fleet applicability, manufacturer's part number, a brief description of the item, expected failure rate, hidden functions, need to be on M.E.L., redundancy (may be unit, system or system management), etc. This work sheet is to be designed to meet the user's requirements and will be included as part of the total MSG-3 documentation for the item.

The approach taken in the following procedure is to provide a logic path for each functional failure. Each functional failure and failure cause must be processed through the logic so that a judgment will be made as to the necessity of a task. The resultant tasks and intervals will form the initial scheduled maintenance .

2-3-3. Logic Diagram

The decision logic diagram (Ref. [Figure 2-2.1]) is used for analysis of systems/powerplant items. The logic flow is designed whereby the user begins the analysis at the top of the diagram, and answers to the "YES" or "NO" questions will dictate direction of the analysis flow.

1. Levels of Analysis

The decision logic has two levels (Ref. [Figure 2-2.1])

a) Level 1 (questions 1, 2, 3 and 4) requires the evaluation of each FUNCTIONAL FAILURE for determination of the Failure Effect Category; i.e., safety, operational, economic, hidden safety or hidden non-safety.

b) Level 2 (questions 5, 6 ,7, 8 and 9, "A" through "F", as applicable) then takes the FAILURE CAUSE(S) for each functional failure into account for selecting the specific type of task(s).

At level 2, the task selection section, paralleling and default logic have been introduced. Regardless of the answer to the first question regarding "Lubrication/Servicing", the next task selection question must be asked in all cases. When following the hidden or evident safety effects path, all subsequent questions must be asked. In the remaining categories, subsequent to the first question, a "YES" answer will allow exiting the logic.

NOTE:	At the user's option, advancement to subsequent questions after deriving a "YES" answer is allowable, but only until the cost of the task is equal to the cost of the failure prevented.

Default logic is reflected in paths outside the safety effects areas by the arrangement of the task selection logic. In the absence of adequate information to answer "YES" or "NO" to questions in the second level, default logic dictates a "NO" answer be given and the subsequent question be asked. As "NO" answers are generated the only choice available is the next question, which in most cases provides a more conservative, stringent and/or costly task.

2-3-4. Procedure

This procedure requires consideration of the functional failures, failure causes, and the applicability/ effectiveness of each task. Each functional failure processed through the logic will be directed into one of five Failure Effect categories [Subject 2-3-6].

Fault-Tolerant Systems ~~Analysis~~

For the purposes of this MSG-3 analysis, a fault-tolerant system is defined as one that is designed with ~~has~~ redundant elements that can fail without impact on safety or operating capability. In other words, redundant elements of the system may fail (fault), but the system itself has not failed. ~~These faults are~~ Individually, and in some combinations, these faults may not be annunciated to the operating crew, but by design ~~and~~ the aircraft may be operated indefinitely with the fault(s) while still satisfying ~~and still satisfy~~ all certification and airworthiness requirements. ~~This means that by definition, functional failures in fault-tolerant systems are hidden non-safety (Failure Effect Category 9).~~

Consequently, this means that the implementation of fault-tolerant system design by the manufacturer enhances the in-service system availability.

MSG-3 is only to be applied to each MSI's functional failure and failure cause for the purpose of maintaining the inherent safety and reliability levels of the aircraft [Subject 2-1-1.]; NOT to maintain enhanced in-service system availability. Tasks may be used to enhance in-service availability by identifying the faults of the fault-tolerant system of operational or economic benefit to an operator. Such tasks are NOT developed by use of MSG-3, NOR should they be submitted for the subsequent MRB report. ~~For example, if a system requires 3 elements in order to satisfy all certification and airworthiness requirements, and the aircraft is designed with 5 elements, any 2 of the 5 elements are considered tolerant. If 3 or more elements have failed, this condition will normally be annunciated to the operating crew.~~

~~Fault-tolerant systems are designed in such a way that the "fault-tolerant" faults can be detected by interrogation of the system. The "interrogation period" selected by the working group can range from very frequent to beyond the design life of the aircraft (i.e., no task selected). Since the methods of system interrogation are also predetermined by design, an alternative methodology for the analysis of fault-tolerant systems is appropriate.~~

~~Method for Analysis of Fault-Tolerant Systems~~

~~The method of analysis of fault-tolerant systems is appropriate because by design:~~

1. ~~The failure-effect category is known (Category 9 - Hidden, Non-Safety), and~~
2. ~~The failure-finding method (systems interrogation) is already designed into the system.~~

~~What remains, therefore, is selection of an applicable and effective task, as determined by the working group, and the establishment of a task interval based on available data from the manufacturer.~~

~~The following method is recommended for the analysis of MSIs that include fault-tolerant functions:~~

1. ~~The manufacture identifies and lists all functions, highlighting those that are fault-tolerant.~~
2. ~~The rationale for identifying fault-tolerant functions must be provided.~~
3. ~~For functions that are not fault-tolerant, the standard analysis process must be used.~~
4. ~~For fault-tolerant functions, the working group must determine/select an applicable and effective task and interval, based on available data from the manufacturer.~~
   a) ~~It is not necessary to list the Functional Failure(s), Failure Effect(s), and Failure Cause(s) on the standard Function-Failure-Effect-Cause sheet.~~
   b) ~~Since the failure-effect category is known (Category 9 - Hidden, Non-Safety), there is no Level 1 analysis required for fault-tolerant functions.~~

~~2-3-5. Consequences of Failure (First Level)~~

~~The decision logic diagram (Ref.~~ [Figure 2-2.1]) facilitates the identification of the tasks required. There are four first level questions.

1. Evident or Hidden Functional Failure

QUESTION 1:	**IS THE OCCURRENCE OF A FUNCTIONAL FAILURE EVIDENT TO THE OPERATING CREW DURING THE PERFORMANCE OF NORMAL DUTIES?**

This question asks if the operating crew will be aware of the loss (failure) of the function during performance of normal operating duties. Question 1 must be asked for each functional failure of the item being analyzed. The intent is to segregate the evident and hidden functional failures. The operating crew consists of qualified flight compartment and cabin attendant personnel who are on duty. Normal duties are those duties associated with the routine operation of the aircraft on a daily basis.

If there is uncertainty about the frequency of use of certain systems, and assumptions are to be made, then the assumptions made must be recorded in the analysis for later verification. This applies equally to assumptions made concerning tests that are performed automatically by electronic equipment.

Ground crew is not part of the operating crew.

Flight crew "normal duties" are described (in part) in the Regulatory Authority approved sections of the Airplane Flight Manual (AFM) and must be accomplished by the flight crew. Working groups may consider these flight crew checks part of the operating crew's "normal duties" for the purpose of categorizing failures as evident in the MSG-3 analysis. It should be documented in the analysis whenever credit is taken for such flight crew checks.

Since the approved AFM is not available during the initial MSG-3 analysis, working groups should document all Level 1 failure analysis that is based on flight crew checks assumed to be included in the AFM. Once the AFM is approved, all Level 1 analyses based on such assumptions must be verified to ensure that these checks are included in the approved AFM. Level 1 analysis must be redone for any assumed flight crew check not included in the approved AFM. System failures which are indicated to the operating crew when performing their normal duties shall be considered as evident.

NOTE: Evidence of AFM tasks which are assumed in the MSG-3 Level 1 analysis submitted to the MRB must be available prior to the MRB Report approval; otherwise, the MSG-3 Level 1 analysis submitted to the MRB must be based on the assumption that these tasks are not part of the crew's normal duties.

A "YES" answer indicates the functional failure is evident; proceed to Question 2 (Ref. [Heading 2-3-5.2]).

A "NO" answer indicates the functional failure is hidden; proceed to Question 3 (Ref. [Heading 2-3-5.3]).

2. Direct Adverse Effect on Safety

QUESTION 2:	**DOES THE FUNCTIONAL FAILURE OR SECONDARY DAMAGE RESULTING FROM THE FUNCTIONAL FAILURE HAVE A DIRECT ADVERSE EFFECT ON OPERATING SAFETY?**

For a "YES" answer the functional failure must have a direct adverse effect on operating safety.

Direct: To be direct the functional failure or resulting secondary damage must achieve its effect by itself, not in combination with other functional failures (no redundancy exists and it is a primary dispatch item).

Adverse Effect on Safety: Safety shall be considered as adversely affected if the consequences of the failure condition would prevent the continued safe flight and landing of the aircraft and/or might cause serious or fatal injury to human occupants.

Operating: This is defined as the time interval during which passengers and crew are on board for the purpose of flight.

A "YES" answer indicates that this functional failure must be treated within the Safety Effects category and task(s) must be developed in accordance with [Heading 2-3-6.1].

A "NO" answer indicates the effect is either operational or economic and Question 4 (Ref. [Heading 2-3-5.4]) must be asked.

3. Hidden Functional Failure Safety Effect

QUESTION 3:	**DOES THE COMBINATION OF A HIDDEN FUNCTIONAL FAILURE AND ONE ADDITIONAL FAILURE OF A SYSTEM RELATED OR BACK-UP FUNCTION HAVE AN ADVERSE EFFECT ON OPERATING SAFETY?**

This question is asked of each hidden functional failure which has been identified in Question 1.

The question takes into account failures in which the loss of the one hidden function (whose failure is unknown to the operating crew) does not of itself affect safety; however, in combination with an additional functional failure (system related or intended to serve as a back-up) has an adverse effect on operating safety.

For hidden functions of safety/emergency systems or equipment (see Glossary), the additional failure is the event for which this function of the system or equipment is designed, and in these cases, a FEC 8 is to be selected. This applies irrespective of whether the function is required by regulation or is carried as an operator option.

If a "YES" answer is determined, there is a safety effect and task development must proceed in accordance with [Heading 2-3-6.4].

A "NO" answer indicates that there is a non-safety effect and will be handled in accordance with [Heading 2-3-6.5].

4. Operational Effect

QUESTION 4:	DOES THE FUNCTIONAL FAILURE HAVE A DIRECT ADVERSE EFFECT ON OPERATING CAPABILITY?

This question asks if the functional failure could have an adverse effect on operating capability:

a) requiring either the imposition of operating restrictions or correction prior to further dispatch; or

b) requiring flight crew use of abnormal or emergency procedures.

This question is asked of each evident functional failure not having a direct adverse effect on safety. The answer may depend on the type of operation.

The assessment of whether or not a failure has an effect on operating capability may require consultation of the MMEL and/or other documentation with operational procedures. As the documents necessary to assess the effect on operating capability are normally not available during the initial MSG-3 analysis, working groups should document all Level 1 failure analyses based on assumptions regarding question 4. Once the affected documents become available, all Level 1 analyses based on such assumptions must be verified.

If the answer to this question is "YES", the effect of the functional failure has an adverse effect on operating capability, and task selection will be handled in accordance with [Heading 2-3-6.2].

A "NO" answer indicates that there is an economic effect and should be handled in accordance with [Heading 2-3-6.3].

2-3-6. Failure Effect Categories (First Level)

Once the analysts have answered the applicable first level questions, they are directed to one of the five Effect Categories

a) Evident Safety (Category 5)

b) Evident Operational (Category 6)

c) Evident Economic (Category 7)

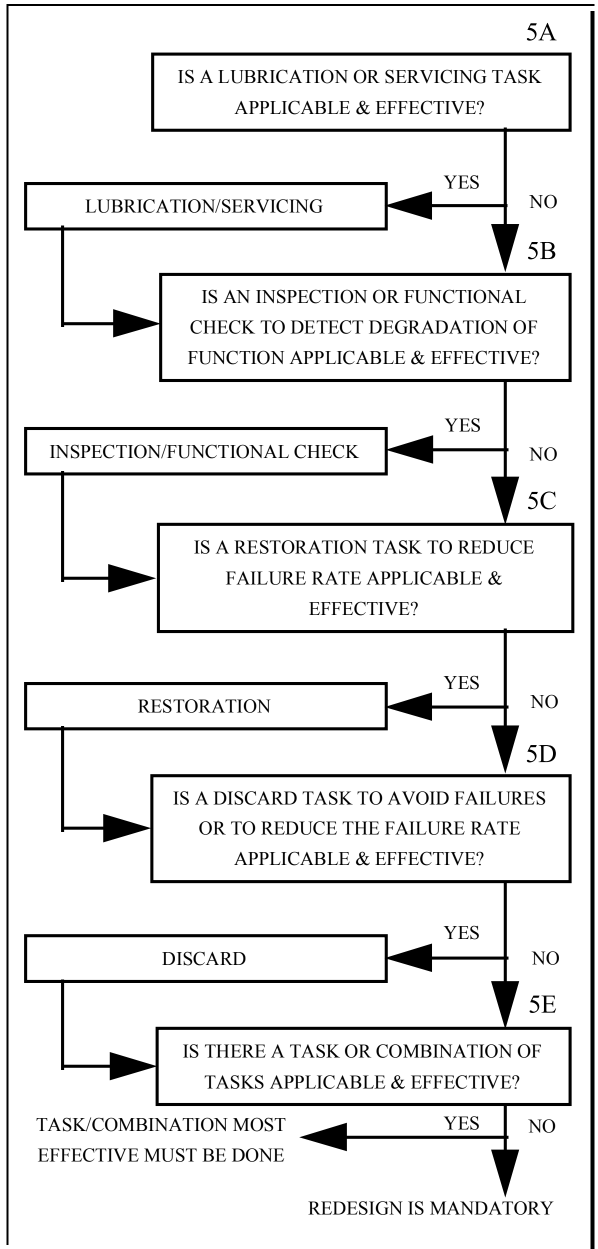
d) Hidden Safety (Category 8)

e) Hidden Non-Safety (Category 9)

1. Evident Safety Effects (Category 5)

The Evident Safety Effect category must be approached with the understanding that a task is required to assure safe operation. All questions in this category must be asked. If no effective task(s) results from this category analysis, then redesign is mandatory. The following is the logic progression for functional failures that have Evident Safety Effects.

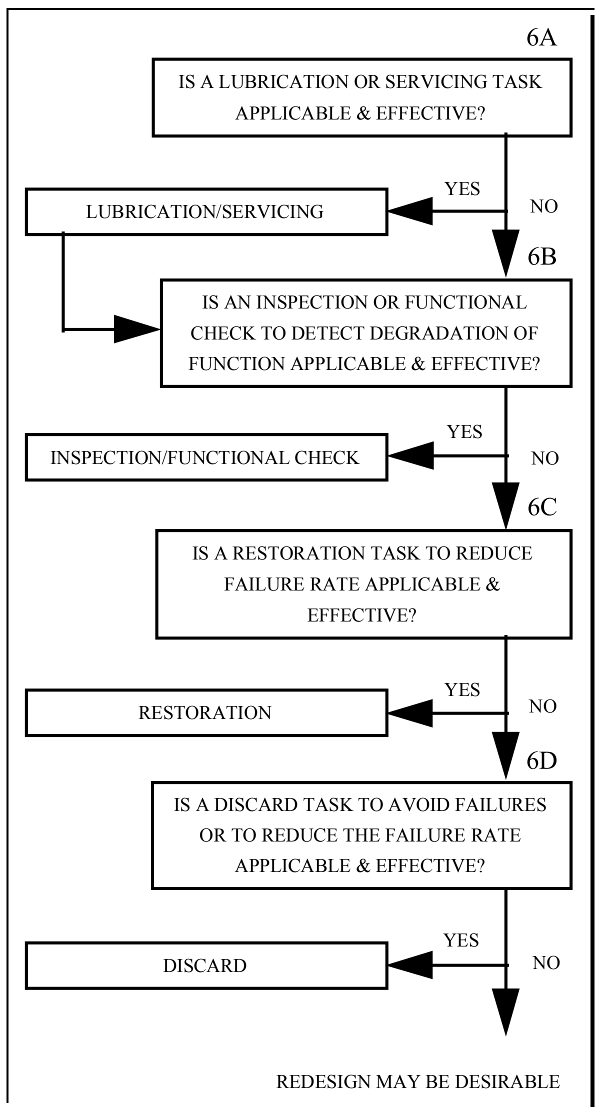
Figure 2-3-6.1. Functional Failures that have Evident Safety Effects



2. Evident Operational Effects (Category 6)

A task(s) is desirable if it reduces the risk of failure to an acceptable level. Analysis of the failure causes through the logic requires the first question (Lubrication/Servicing) to be answered. Either a "YES" or "NO" answer of question "A" still requires movement to the next level; from this point on, a "YES" answer will complete the analysis and the resultant task(s) will satisfy the requirements. If all answers are "NO", then no task has been generated. If operational penalties are severe, a redesign may be desirable. The following is the logic progression for functional failures that have Evident Operational Effects.

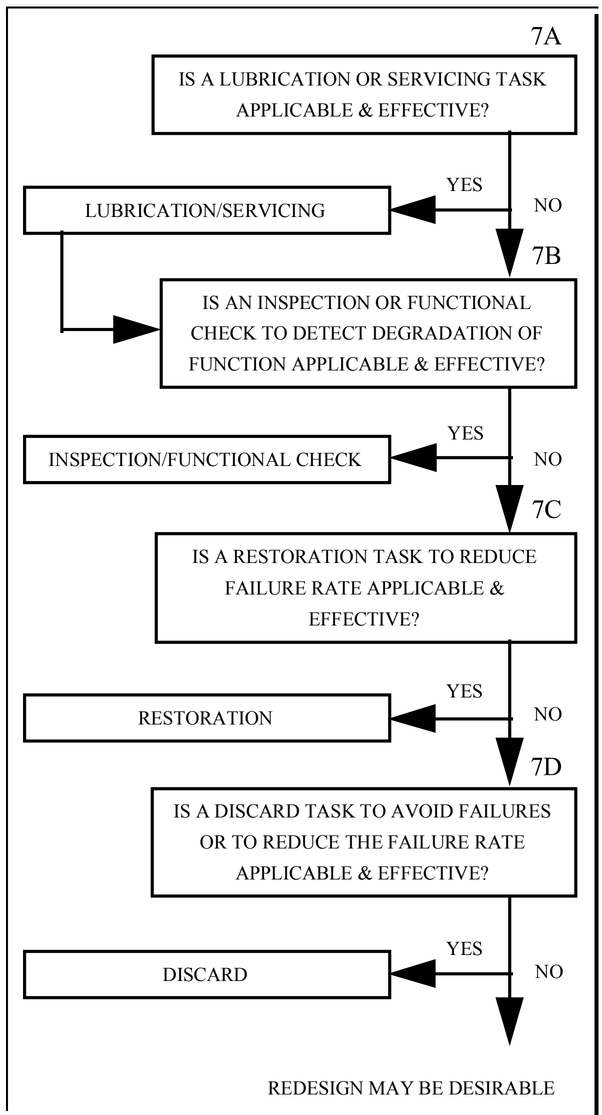
Figure 2-3-6.2. Functional Failures that have Evident Operational Effects



3. Evident Economic Effects (Category 7)

A task(s) is desirable if the cost of the task is less than the cost of repair. Analysis of the failure causes through the logic requires the first question (Lubrication/Servicing) to be answered. Either a "YES" or "NO" answer to question "A" still requires movement to the next level; from this point on, a "YES" answer will complete the analysis and the resultant task(s) will satisfy the requirements. If all answers are "NO", no task has been generated. If economic penalties are severe, a redesign may be desirable. The following is the logic progression for functional failures that have Evident Economic Effects.

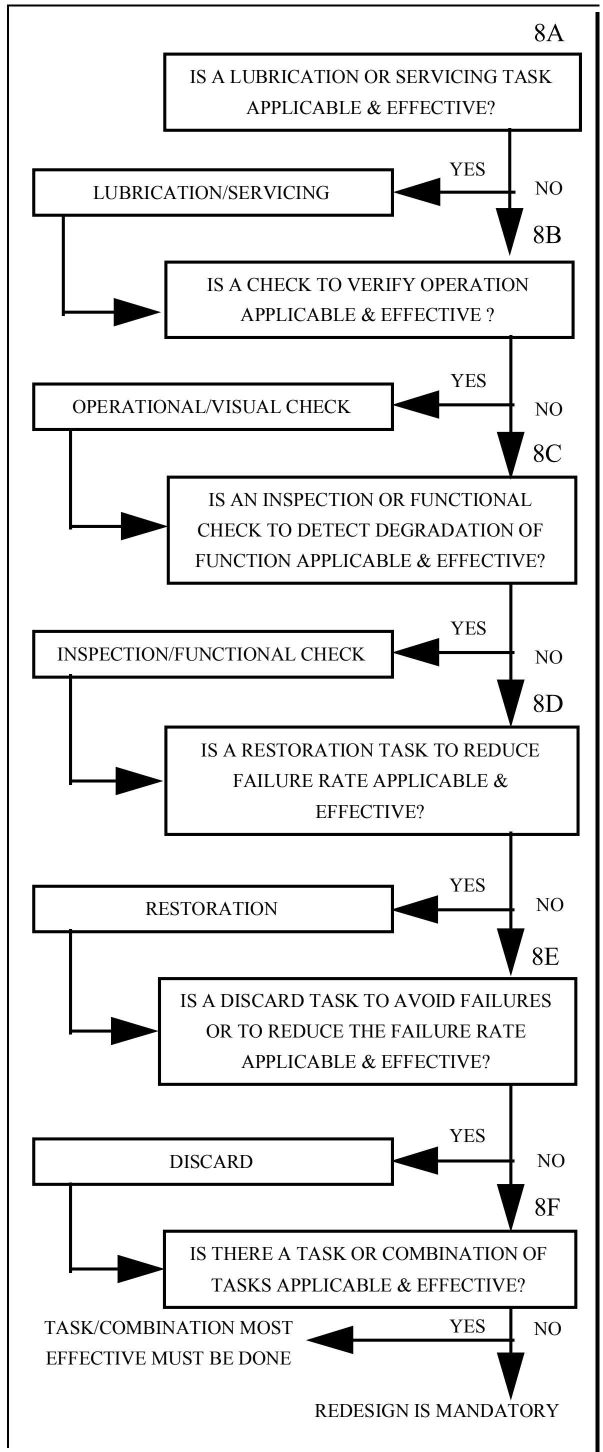
Figure 2-3-6.3. Functional Failures that have Evident Economic Effects



4. Hidden Function Safety Effects (Category 8)

The **Hidden Function Safety Effect** requires a task(s) to assure the availability necessary to avoid the safety effect of multiple failures. All questions must be asked. If there are no tasks found effective, then redesign is mandatory. The following is the logic progression for functional failures that have Hidden Function Safety Effects.

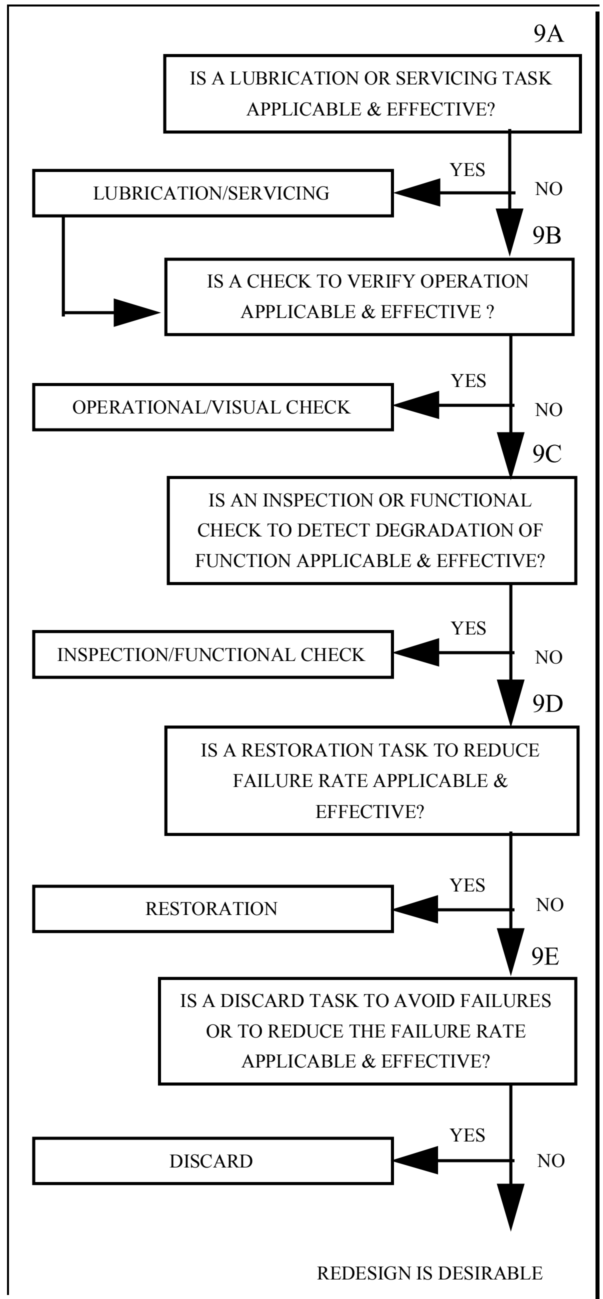
Figure 2-3-6.4. Functional Failures that have Hidden Function Safety Effects



5. Hidden Function Non-Safety Effects (Category 9)

The Hidden Function Non-Safety Effect category indicates that a task(s) may be desirable to assure the availability necessary to avoid the economic effects of multiple failures. Movement of the failure causes through the logic requires the first question (Lubrication/Servicing) to be answered. Either a "YES" or "NO" answer still requires movement to the next level; from this point on, a "YES" answer will complete the analysis and the resultant task(s) will satisfy the requirements. If all answers are "NO", no task has been generated. If economic penalties are severe, a redesign may be desirable. The following is the logic progression for functional failures that have Hidden Function Non-Safety Effects.

Figure 2-3-6.5. Functional Failures that have Hidden Function Non-Safety Effects



2-3-7. Task Development (Second Level)

Task development is handled in a similar manner for each of the five Effect categories. For task determination, it is necessary to apply the failure causes for the functional failure to the second level of the logic diagram. There are six possible task resultant questions in the Effect categories as follows

1. Lubrication/Servicing (All Categories)

QUESTION 5A, 6A, 7A, 8A, 9A:	**IS A LUBRICATION OR SERVICING TASK APPLICABLE AND EFFECTIVE?**

Any act of lubrication or servicing for the purpose of maintaining inherent design capabilities.

1.1. Applicability Criteria

The replenishment of the consumable must reduce the rate of functional deterioration.

1.2. Effectiveness Criteria - Safety

The task must reduce the risk of failure.

1.3. Effectiveness Criteria - Operational

The task must reduce the risk of failure to an acceptable level.

1.4. Effectiveness Criteria - Economic

The task must be cost-effective.

2. Operational/Visual Check (Hidden Functional Failure Categories Only)

QUESTION 8B & 9B.	IS A CHECK TO VERIFY OPERATION APPLICABLE AND EFFECTIVE?

An operational check is a task to determine that an item is fulfilling its intended purpose. The check does not require quantitative tolerances. This is a failure finding task.

A visual check is an observation to determine that an item is fulfilling its intended purpose. The check does not require quantitative tolerances. This is a failure finding task.

2.1. Applicability Criteria

Identification of failure must be possible.

2.2. Effectiveness Criteria - Safety

The task must ensure adequate availability of the hidden function to reduce the risk of a multiple failure.

2.3. Effectiveness Criteria - Economic

The task must ensure adequate availability of the hidden function in order to avoid economic effects of multiple failures and must be cost-effective.

3. Inspection/Functional Check (All Categories)

QUESTION 5B, 6B, 7B, 8C & 9C.	**IS AN INSPECTION OR FUNCTIONAL CHECK TO DETECT DEGRADATION OF FUNCTION APPLICABLE AND EFFECTIVE?**

An inspection is:

A. GENERAL VISUAL INSPECTION (GVI)

A visual examination of an interior or exterior area, installation or assembly to detect obvious damage, failure or irregularity. This level of inspection is made from within touching distance, unless otherwise specified. A mirror may be necessary to enhance~~d~~ visual access to all exposed surfaces in the inspection area. This level of inspection is made under normally available lighting conditions such as daylight, hangar lighting, flashlight or drop-light and may require removal or opening of access panels or doors. Stands, ladders or platforms may be required to gain proximity to the area being checked.

OR

B. DETAILED INSPECTION (DET)

An intensive examination of a specific item, installation or assembly to detect damage, failure or irregularity. Available lighting is normally supplemented with a direct source of good lighting at an intensity deemed appropriate. Inspection aids such as mirrors, magnifying lenses, etc. may be necessary. Surface cleaning and elaborate access procedures may be required.

OR

C. SPECIAL DETAILED INSPECTION (SDI)

An intensive examination of a specific item, installation, or assembly to detect damage, failure or irregularity. The examination is likely to make extensive use of specialized Inspection Techniques and/or equipment. Intricate cleaning and substantial access or disassembly procedure may be required.

A functional check is a quantitative check to determine if one or more functions of an item performs within specified limits.

3.1. Applicability Criteria

Reduced resistance to failure must be detectable, and there exists a reasonably consistent interval between a deterioration condition and functional failure.

3.2. Effectiveness Criteria - Safety

The task must reduce the risk of failure to assure safe operation.

3.3. Effectiveness Criteria - Operational

The task must reduce the risk of failure to an acceptable level.

3.4. Effectiveness Criteria - Economic

The task must be cost-effective; i.e., the cost of the task must be less than the cost of the failure prevented.

4. Restoration (All Categories)

QUESTION 5C, 6C, 7C, 8D, & 9D.	IS A RESTORATION TASK TO REDUCE FAILURE RATE APPLICABLE AND EFFECTIVE?

That work necessary to return the item to a specific standard.

Since restoration may vary from cleaning or replacement of single parts up to a complete overhaul, the scope of each assigned restoration task has to be specified.

4.1. Applicability Criteria

The item must show functional degradation characteristics at an identifiable age and a large proportion of units must survive to that age. It must be possible to restore the item to a specific standard of failure resistance.

4.2. Effectiveness Criteria - Safety

The task must reduce the risk of failure to assure safe operation.

4.3. Effectiveness Criteria - Operational

The task must reduce the risk of failure to an acceptable level.

4.4. Effectiveness Criteria - Economic

The task must be cost-effective: i.e., the cost of the task must be less than the cost of the failure prevented.

5. Discard (All Categories)

QUESTION 5D, 6D, 7D, 8E, 9E	IS A DISCARD TASK TO AVOID FAILURES OR TO REDUCE THE FAILURE RATE APPLICABLE AND EFFECTIVE?

The removal from service of an item at a specified life limit.

Discard tasks are normally applied to so-called single celled parts such as cartridges, canisters, cylinders, engine disks, safe-life structural members, etc.

5.1. Applicability Criteria

The item must show functional degradation characteristics at an identifiable age and a large proportion of units must survive to that age.

5.2. Effectiveness Criteria - Safety

A safe-life limit must reduce the risk of failure to assure safe operation.

5.3. Effectiveness Criteria - Operational

The task must reduce the risk of failure to an acceptable level.

5.4. Effectiveness Criteria - Economic

An economic-life limit must be cost-effective: i.e., the cost of the task must be less than the cost of the failure prevented.

6. Combination (Safety Categories Only)

QUESTION 5E, 8F.	**IS THERE A TASK OR COMBINATION OF TASKS APPLICABLE AND EFFECTIVE?**

Since this is a safety category question and a task is required, all possible avenues must be analyzed. To do this, a review of the task(s) that are applicable is necessary. From this review the most effective task(s) must be selected.

7. Task Selection Criteria

Table 2-3-7.1. Criteria for Task Selection

TASK	APPLICABILITY	SAFETY EFFECTIVENESS	OPERATIONAL EFFECTIVENESS	ECONOMIC EFFECTIVENESS
LUBRICATION OR SERVICING	The replenishment of the consumable must reduce the rate of functional deterioration.	The task must reduce the risk of failure.	The task must reduce the risk of failure to an acceptable level.	The task must be cost effective.
OPERATIONAL OR VISUAL CHECK	Identification of failure must be possible.	The task must ensure adequate availability of the hidden function to reduce the risk of a multiple failure.	Not applicable.	The task must ensure adequate availability of the hidden function in order to avoid economic effects of multiple failures and must be cost effective.
INSPECTION OR FUNCTIONAL CHECK	Reduced resistance to failure must be detectable, and there exists a reasonably consistent interval between a deterioration condition and functional failure.	The task must reduce the risk of failure to assure safe operation.	The task must reduce the risk of failure to an acceptable level.	The task must be cost effective; i. e., the cost of the task must be less than the cost of the failure prevented.
RESTORATION	The item must show functional degradation characteristics at an identifiable age, and a large proportion of units must survive to that age. It must be possible to restore the item to a specific standard of failure resistance.	The task must reduce the risk of failure to assure safe operation.	The task must reduce the risk of failure to an acceptable level.	The task must be cost effective; i.e., the cost of the task must be less than the cost of the failure prevented.
DISCARD	The item must show functional degradation characteristics at an identifiable age and a large proportion of units must survive to that age.	The safe life limit must reduce the risk of failure to assure safe operation.	The task must reduce the risk of failure to an acceptable level.	An economic life limit must be cost effective; i.e., the cost of the task must be less than the cost of the failure prevented.

2-3-8. Systems/Powerplant Task Interval Determination

1. General

As part of the MSG-3 Logic-Analysis, the Maintenance Working Group (MWG) determines the interval of each scheduled maintenance task that satisfies both the applicability & effectiveness criteria. The MWGs should select the most appropriate interval for each maintenance task based on available data and good engineering judgement. In the absence of specific data on failure rates & characteristics, intervals for systems tasks are largely determined based on service experience with similar systems/components.

The information needed to determine optimum intervals is ordinarily not available until after the equipment enters service. In many cases previous experience with the same or a similar item serves as a guide. The difficulty of establishing "correct" intervals for maintenance tasks is essentially an information problem and one that continues throughout the operating life of the equipment.

A task should not be done more often than experience or other data suggests simply because it is easily accomplished (doing tasks more often than necessary increases the chance for maintenance-induced errors and may have an adverse effect on reliability and safety).

2. Sources of Information

The MWG should consider the following in determining the most appropriate task interval:

- manufacturer's tests and technical analysis
- manufacturer's data and/or vendor recommendations
- customer requirements
- service experience gained with comparable or identical components and subsystems
- 'best engineering estimates'

In order to arrive at the 'best initial' maintenance interval for each task, each MWG must assess the interval based on all relevant data that is available. As part of this assessment, the MWG should consider answering the following questions in order to determine the most appropriate interval:

- What service experience is available for common/similar parts/components/systems on other aircraft that defines an effective task interval?
- What design improvements have been incorporated that warrant a longer interval between checks?
- What task interval is recommended by the vendor/manufacturer based on test data or failure analysis?

3. Task Interval Parameters

Task intervals are established in terms of the measure of exposure to the conditions that cause the failure at which the task is directed. The most widely used usage parameters are:

- calendar time
- flight hours
- flight cycles
- Engine/APU hours/cycles.

Task interval determination consists of identifying the correct usage parameter and its associated numerical interval or the appropriate letter check. Both intervals expressed in usage parameters and/or letter checks are acceptable and may be used in line with specific procedures established for a given program. If an interval is to be expressed in a usage parameter, interval determination consists of the following steps:

- The first step is to define the predominant (governing) usage parameter(s). For many Systems/Powerplant tasks, flight hours is the predominant usage parameter; however, for some tasks, flight cycles or calendar time may be the predominant usage parameter. Intervals may also be expressed in terms of more than one usage parameter.
- The second step is to determine the interval in terms of the selected usage parameter subject to the criteria discussed below.

As a matter of convenience, usage of letter checks for individual tasks and the establishment of a check interval framework may be considered by the ISC; e.g., if no predominant usage parameter can be identified.

For some tasks, it may be appropriate for the MWG to consider specifying an initial interval that is different from the repeat interval.

4. Task Interval Selection Criteria

In addition to the general guidelines included in [Heading 2-3-8.1], the following detailed recommendations should be considered:

Lubrication/Servicing (failure prevention):

- The interval should be based on the consumable's usage rate, the amount of consumable in the storage container (if applicable) and the deterioration characteristics.
- Typical operating environments and climatic conditions are to be considered when assessing the deterioration characteristics.

Operational Checks & Visual Checks (failure-finding):

- Consider the length of potential exposure time to a hidden failure and the potential consequences if the hidden function is unavailable.
- Task intervals should be based on the need to reduce the probability of the associated multiple failure to a level considered tolerable by the MWG.

- The failure-finding task and associated interval selection process should take into account any probability that the task itself might leave the hidden function in a failed state.

Inspections & Functional checks (potential failure finding):

- There should exist a clearly defined potential failure condition.
- The task interval should be less than the shortest likely interval between the point at which a potential failure becomes detectable and the point at which it degrades into a functional failure. (If the specific failure data is available, this interval may be referred to as the P to F interval.)
- It should be practical to do the task at this interval.
- The shortest time between the discovery of a potential failure and the occurrence of the functional failure should be long enough for an appropriate action to be taken to avoid, eliminate or minimize the consequences of the failure mode.

Restoration and Discard (failure avoidance):

- Intervals should be based on the "identifiable age" when significant degradation begins and where the conditional probability of failure increases significantly.
- Vendor recommendations based on in-service experience of similar parts should also be taken into consideration.
- A sufficiently large proportion of the occurrences of this failure should occur after this age to reduce the probability of premature failure to a level that is tolerable.

5. "Access-Defined" Inspection Intervals

Occasionally, it is impossible to accomplish a task until a component/system is removed/displaced; the interval of such a task should be coordinated with the removal/displacement of that component/system.

If the component/system is removed/displaced at intervals shorter than what is required for the task, then the task interval should be defined by the MWG as the removal/displacement interval (scheduled or unscheduled). If the task interval is shorter than the removal/displacement interval, then an access-defined interval is not appropriate.

NOTE:	If the MWG selects an access-defined interval, consideration should be given to defining a minimum interval between tasks. For example, if "Engine Change" is the access-defined interval, and the engine is removed soon after the last engine change due to an unscheduled event, the task should not be repeated unless a minimum number of hours have elapsed.

6. Certification Maintenance Requirements (CMRs)

In addition to those tasks and intervals established through MSG-3 analysis, scheduled maintenance tasks may arise within the FAR 25.1309 certification process.

A CMR is a required periodic task, established during the design certification of the airplane as an operating limitation of the type certificate. CMRs are a subset of the tasks identified during the type certification process. CMRs usually result from a formal, numerical analysis conducted to show compliance with catastrophic and hazardous failure conditions. A CMR is intended to detect safety significant latent failures that would, in combination with one or more other specific failures or events, result in a hazardous or catastrophic failure condition.

It is important to note that CMRs are derived from a fundamentally different analysis process than the maintenance tasks and intervals that result from MSG-3 analysis. The process for coordinating MSG-3 derived tasks with CMRs is described in detail in AC 25-19 and involves a Certification Maintenance Coordination Committee (CMCC) that may influence the MWG's interval decision.

7. Sampling

Sampling may be established for items defined in the Systems and Powerplant Analysis Procedures.

Sampling is an examination of a specific number of items at defined intervals in order to confirm that there are no unexpected degradation characteristics. Non-sampled items may continue in service until sampling results highlight the need for additional scheduled maintenance.

2-4. Aircraft Structural Analysis Procedure

This section contains guidelines for developing scheduled maintenance tasks for aircraft structure. These are designed to relate the scheduled maintenance tasks to the consequences of structural damage remaining undetected. Each structural item is assessed in terms of its significance to continuing airworthiness, susceptibility to any form of damage, and the degree of difficulty involved in detecting such damage. Once this is established, scheduled structural maintenance can be developed which can be shown to be effective in detecting and preventing structural degradation due to fatigue, environmental deterioration, or accidental damage throughout the operational life of the aircraft. The structural maintenance task(s) developed as part of the scheduled structural maintenance are used to satisfy aircraft type certification and MRB requirements.

Mandatory replacement times for structural safe-life parts are included in the Airworthiness Limitations, required by the regulatory authorities as part of the Instructions for Continued Airworthiness. Some of the items requiring fatigue related inspections may also be included, as well as specific Corrosion Prevention and Control Program (CPCP) tasks which subsequently warrant inclusion, based on the in-service experience of the operators.

Requirements for detecting **Accidental Damage (AD)**, **Environmental Deterioration (ED)**, **Fatigue Damage (FD)**, and procedures for preventing and/or controlling corrosion form the basis for the MRB structural maintenance. However, all FD inspection requirements may not be available when the aircraft enters service. In such cases the manufacturer shall propose, prior to the entry of the aircraft into service, an appropriate time frame for completing the FD inspection requirements.

If the need arises, procedures should be developed for any new material (e.g., new composite material) whose damage characteristics do not follow those procedures described in this document

2-4-1. Aircraft Structure Defined

Aircraft structure consists of all load carrying members including wings, fuselage, empennage, engine mountings, landing gear, flight control surfaces and related points of attachment. The actuating portions of items such as landing gear, flight controls, doors, etc. will be treated as systems components and will be analyzed as described in [Section 2-3]. Attachment of the actuators to the airframe will be treated as structure.

1. Significant and Other Structure

Structure can be subdivided into items according to the consequences of their failure to aircraft safety as follows

a. A **Structural Significant Item (SSI)** is any detail, element or assembly, which contributes significantly to carrying flight, ground, pressure or control loads, and whose failure could affect the structural integrity necessary for the safety of the aircraft.

   An SSI may or may not contain a Principal Structural Element (PSE). A PSE is any element which contributes significantly to carrying flight, ground, pressure, or control loads, and whose consequence of failure is catastrophic. All PSEs are considered as significant structure.

b. **Other Structure** is that which is judged not to be a Structural Significant Item. It is defined both externally and internally within zonal boundaries.

2-4-2. Scheduled Structural Maintenance

The primary objective of the scheduled structural maintenance is to maintain the inherent airworthiness throughout the operational life of the aircraft in an economical manner. To achieve this, the inspections must meet the detection requirements from each of the AD, ED and FD assessments. Full account may be taken of all applicable inspections occurring in the fleet.

Inspections related to detection of AD/ED are applicable to all aircraft when they first enter service. Changes or adjustments can be made to these inspections based on individual operator experience, when approved by their local regulatory authority.

Additional maintenance tasks (related to ED in metallics) to control corrosion to Level 1 or better are applicable at a threshold which is established during the aircraft type certification process. These are based on manufacturer and operator experience with similar aircraft structure, taking into consideration differences in relevant design features e.g. choice of material, assembly process, corrosion protection systems, galley and toilet design etc. See also [Heading 2-4-2.5] entitled Corrosion Prevention and Control Program.

Non-metallic structure is susceptible to damage and/or deterioration (e.g., disbonding and delamination). Such structure that is classified as an SSI will require inspections to ensure adequate strength throughout its operational life. Susceptibility to long term deterioration is assessed with regard to the operating environment. Areas such as major attachments, joints with metallic parts and areas of high stress levels are suggested as likely candidates for inspection.

Inspections related to FD detection in metals are applicable after a threshold, which is established during the aircraft type certification process. At the time the fatigue related inspections are implemented, sampling can be used, where it is applicable and effective. The fatigue related inspections are based directly on the manufacturer's approved damage tolerance evaluations and changes or adjustments by the operators require use of an approved procedure.

Inspections related to FD detection in non-metals may not be required as their design is based on a "no-damage growth" design philosophy, and substantiated by testing.

Where no service experience exists with similar structure, the structural maintenance requirements shall be based on manufacturer's recommendations.

Proposed initial scheduled maintenance tasks, to be used as the basis for the structural maintenance, are established for each aircraft type by the Industry Steering Committee on the basis of:

a. Operator experience

b. Manufacturer's proposals

c. Considerations of systems analysis requirements

1. Structural Maintenance Tasks

As part of the structural maintenance development procedure, applicable and effective structural maintenance tasks are selected for each deterioration process of the SSI. To assure a direct correlation between the structural damage tolerance evaluations and the structural maintenance, it is necessary to describe each task.

To all extents possible, the inspection methods specified in the tasks should use the standard set of definitions included in the MSG-3 glossary. Changes and/or additions to the inspection methods and definitions must be approved by the Industry Steering Committee.

2. Inspection Thresholds

The inspection threshold for each SSI inspection task is a function of the source of damage as follows:

a. **Accidental Damage** - The first inspection (threshold) for accidental damage normally corresponds to a period equal to the defined repeat inspection interval, from the time of first entry into service.

b. **Environmental Deterioration** - The initial inspection thresholds for all levels of inspection are based on existing relevant service experience, manufacturers recommendations, and/or a conservative age exploration process.

c. **Fatigue Damage** - Inspections directly related to fatigue damage detection will occur after a threshold(s) to be established by the manufacturer and approved by the appropriate regulatory authority Thresholds are normally established as part of the damage tolerance certification requirements. These are subject to change as service experience, additional testing, or analysis work is obtained.

3. Repeat Inspection Intervals

After each inspection has been conducted, the repeat interval sets the period until the next inspection:

a. **Accidental Damage** - The repeat interval should be based on operator and manufacturer experience with similar structure. Selected intervals will normally correspond to single or multiple levels of the scheduled maintenance check intervals.

b. **Environmental Deterioration** - The repeat interval for detection/prevention/control of ED (corrosion, stress corrosion, delamination, disbonding, etc.) should be based on existing relevant service experience and/or manufacturers recommendations.

c. **Fatigue Damage** - The repeat intervals for fatigue related inspections are based on the damage tolerance evaluations. These are used to demonstrate that applicable and effective inspections provide sufficient probability of detecting fatigue damage for each SSI.

4. Fatigue Related Sampling Inspections

Transport aircraft with the highest number of flight cycles are most susceptible to initial fatigue cracking in the fleet. This means that adequate inspections on such aircraft will provide the greatest benefits for timely detection of fatigue damage. Such sampling inspections are developed on the basis of appropriate statistical variables, including:

a. The number of aircraft inspected.

b. The inspection methods and repeat intervals.

c. The number of flight cycles completed.

A list of SSIs that are suitable for a fatigue related sampling inspections will be established by the Structures Working Group and submitted to the Industry Steering Committee for approval and inclusion in the MRB report proposal. Full details of the fatigue related sampling inspections will be established by a joint operator/ manufacturer task force, based on the manufacturer's technical evaluations, prior to aircraft exceeding the fatigue damage threshold(s).

5. Corrosion Prevention and Control Programs (CPCP)

A Corrosion Prevention and Control Program should be established to maintain the aircraft's resistance to corrosion as a result of systematic (e.g. age related) deterioration through chemical and/or environmental interaction.

The program is expected to allow control of the corrosion on the aircraft to **Corrosion Level 1** or better. The CPCP should be based on the ED analysis, assuming an aircraft operated in a typical environment. If corrosion is found to exceed Level 1 at any inspection time, the corrosion control program for the affected area must be reviewed by the operator with the objective to ensure Corrosion Level 1 or better.

6. Age Exploration Program

An age exploration program may be desirable to verify the aircraft's resistance to corrosion deterioration before the Corrosion Prevention and Control Program Task Thresholds.

To improve on the specific task intervals for non-metallic significant structure, an age exploration program may be desirable to verify the rate of structural deterioration.

Guidelines for age exploration should be established by the Structures Working Group and submitted to the Industry Steering Committee for approval and inclusion in the scheduled structural maintenance tasks and intervals.

7. Zonal Inspections

Some parts of the inspection requirements for SSIs and most of the items categorized as Other Structure can be provided by the zonal inspections (Ref. [Section 2-5]).

Tasks and intervals included in the zonal inspections should be based on operator and manufacturer experience with similar structure. For structure containing new materials and/or construction concepts, tasks and intervals may be established based on assessment of the manufacturer's recommendations.

8. Inspection Results

The type certificate holder (manufacturer) and the operators will implement a satisfactory system for the effective collection and dissemination of service experience from the scheduled structural maintenance.

This process will supplement the system which is required by existing regulations for reporting occurrences of failures, malfunctions or defects (e.g. Service Difficulty Reports).

2-4-3. Damage Sources and Inspection Requirements

This section describes the damage sources and inspection requirements to be considered when developing the scheduled structural maintenance.

1. Damage Sources

The assessment of structure for the selection of maintenance tasks should consider the following damage sources

a. **Accidental Damage (AD)**, which is characterized by the occurrence of a random discrete event which may reduce the inherent level of residual strength. Sources of such damage include ground and cargo handling equipment, foreign objects, erosion from rain, hail, lightning, runway debris, spillage, freezing, thawing, etc., and those resulting from human error during aircraft manufacture, operation or maintenance that are not included in other damage sources.

   The same sources of accidental damage as those considered for metallic materials are to be considered for non-metallic material such as composites. The consequence of a damage may not be readily apparent and may include internal damage, e.g., disbonding or delamination.

   Large size accidental damage, such as that caused by engine disintegration, bird strike or major collision with ground equipment, will be readily detectable and no maintenance task assessment is required.

b. **Environmental Deterioration (ED)**, which is characterized by structural deterioration as a result of a chemical interaction with its climate or environment. Assessments are required to cover corrosion, including stress corrosion, and deterioration of non-metallic materials. Corrosion may or may not be time/usage dependent. For example, deterioration resulting from a breakdown in surface protection is more probable as the calendar age increases; conversely, corrosion due to galley spillage is a randomly occurring discrete event.

Stress corrosion cracking in a given environment is directly dependent upon the level of sustained tensile stress which may result from heat treatment, forming, fit-up, or misalignment.

In contrast to the environmental deterioration process of metallic structures, non-metallic structures such as composites are not normally susceptible to degradation due to the environment. However, the effect of long-term aging in an operating environment has to be taken into consideration when developing the structural maintenance.

c. **Fatigue Damage (FD)** which is characterized by the initiation of a crack or cracks due to cyclic loading and subsequent propagation. It is a cumulative process with respect to aircraft usage (flight cycles or flight hours).

2. Inspection Requirements

Inspection requirements in relation to the damage sources are as follows:

a. **Accidental Damage (AD)**, stress corrosion and some other forms of corrosion are random in nature and can occur any time during the aircraft service life. In such cases, inspection requirements apply to all aircraft in the fleet throughout their operational lives.

b. Most forms of corrosion are time/usage dependent and more likely to occur as the fleet ages. In such cases, operator and manufacturer experience on similar structure can be used to establish appropriate maintenance tasks (including CPCP tasks) for the control of environmental deterioration.

The deterioration of non-metallic structures such as composites has to be taken into consideration when establishing maintenance tasks. Appropriate inspection levels and frequencies should be based on existing relevant service experience and manufacturer's recommendations.

c. Detectable size fatigue cracking is not normally anticipated in primary airframe structure until the fleet has matured. Thereafter, scheduled structural maintenance may require revision.

For most transport aircraft structure, aircraft with the highest number of flight cycles are more susceptible to initial fatigue cracking in the fleet and are suitable candidates for a fatigue related sampling, should this be applicable and effective.

2-4-4. Scheduled Structural Maintenance Development

The scheduled structural maintenance tasks and intervals are based on an assessment of structural design information, fatigue and damage tolerance evaluations, service experience with similar structure and pertinent test results.

The assessment of structure for selection of maintenance tasks should include the following

a. The sources of structural deterioration:

1. Accidental Damage
2. Environmental Deterioration
3. Fatigue Damage

b. The susceptibility of the structure to each source of deterioration.

c. The consequences of structural deterioration to continuing airworthiness

   1. Effect on aircraft (e.g. loss of function or reduction of residual strength).

   2. Multiple site or multiple element fatigue damage.

   3. The effect on aircraft flight or response characteristics caused by the interaction of structural damage or failure with systems or powerplant items.

   4. In-flight loss of structural items.

d. The applicability and effectiveness of various methods of preventing, controlling or detecting structural deterioration, taking into account inspection thresholds and repeat intervals.

1. Procedure

The procedure for developing structural maintenance tasks is shown in the logic diagram (Ref. [Figure 2-4-4.1]) and described by a series of process steps (P1, P2, P3, etc.) and decision steps (D1, D2, D3, etc.) as follows:

a. The structural maintenance analysis is to be applied to all aircraft structure which is divided into zones or areas (P1) and structural items (P2) by the manufacturer.

b. The manufacturer categorizes each item as structurally significant (SSI) or Other Structure, on the basis of the consequences to aircraft safety of item failure or malfunction (D1).

c. The same procedure is repeated until all structural items have been categorized.

d. Items categorized as Structural Significant Item (SSI) (P3) are listed as SSI's. They are to be categorized as safe-life or damage-tolerant (D5), and are additionally subjected to AD/ED/CPCP analysis (either as metallic or non-metallic structure).

e. Items categorized as Other Structure (P4) are compared to similar items on existing aircraft (D2). Maintenance recommendations are developed by the Structures Working Group (SWG) for items which are similar and by the manufacturer for those which are not, e. g., new materials or design concepts (P5). All tasks selected by the SWG (P6) are included in the scheduled structural maintenance (P20).

f. The manufacturer must consider two types of AD/ED analysis; for metallic structure (P7-P9) and for non-metallic structure (P10-P14). Each SSI may consist of one or the other, or both.

g. Inspection requirements for timely detection of Accidental Damage (AD) and Environmental Deterioration (ED) are determined for all metallic SSIs (P7). These can be determined for individual SSIs or groups of SSIs which are suitable for comparative assessments on the basis of their location, boundaries, inspection access, analysis breakdown, etc. The manufacturer's rating systems (Ref. [Subject 2-4-5]) are used to determine these requirements.

h. For each SSI containing metallic structure, the maintenance requirements are determined (P8) such that the expectations of the CPCP (Ref. [Heading 2-4-2.5]) are fulfilled.

i. The inspection requirement of the ED analysis is compared with the requirement of the CPCP (D3). If they are similar or identical, the ED task will cover the CPCP requirement. If the CPCP task requirement is not met, the ED task has to be reviewed and/or additional and separate CPCP tasks have to be determined (P9).

j. The process (P7, P8, P9) is repeated until all metallic SSIs are examined.

k. Each SSI containing non-metallic structure is assessed as to its sensitivity to Accidental Damage (AD) or not (D4), on the basis of SSI location, frequency of exposure to the damage source, and location of damage site.

l. SSIs containing non-metallic structure classified as sensitive to Accidental Damage (AD), are assessed for frequency of exposure to each likely damage source and the likelihood of multiple occurrence (P10), and its impact on the Environmental Deterioration (ED) analysis (P11).

m. When applicable, AD impact on the ED analysis is considered when the SSI is assessed for sensitivity to structural composition (P12) and sensitivity to the environment (P13), considering the material type.

n. Inspection requirements for timely detection of damage (e.g., delamination and disbonding) are determined for all SSIs containing non-metallic structure (P14). The manufacturer's rating systems (Ref.[Subject 2-4-5]) are used to determine these requirements.

o. All tasks resulting from AD/ED analysis (Figure 2-4-4.3 and/or Figure 2-4-4.4), selected by the SWG, are included in the structural maintenance (P20).

p. The manufacturer categorizes each SSI as damage tolerant or safe-life (D5).

q. For each item categorized as safe-life, the manufacturer determines the safe-life limit (P15) which is included in the aircraft Airworthiness Limitations (P19). No fatigue related inspection is required to assure continuing airworthiness.

r. All remaining SSIs are damage tolerant and the manufacturer determines if timely detection of fatigue damage is dependent on scheduled inspections (P16). Scheduled fatigue related inspection may not be required for SSIs designed to carry the required load with damage that will be readily detectable during routine operation of the aircraft (D6).

s. Visual inspections during appropriate scheduled maintenance checks are used, where applicable and effective, to provide the necessary fatigue damage detection opportunities (D7).

t. Applicable nondestructive inspection (NDI) methods, during appropriate scheduled maintenance checks, are used to provide necessary fatigue damage detection opportunities when visual inspections are inadequate (D8).

u. Details of the fatigue related inspection requirements are presented to the SWG who determine if they are feasible (D9). Improved inspection access and/or redesign of the SSI may be required if no practical and effective visual and/or nondestructive inspections are available (D10,P17). If this is not feasible for the manufacturer, the SSI must be categorized as safe-life (P15).

v. Fatigue related inspection requirements selected by the SWG are included in the preliminary Scheduled Structural Maintenance (P20).

w. To support Type Certification, selected SSIs (P18, P19) that will eventually be included in the fatigue related inspection should be listed in the Airworthiness Limitations document.

x. The FD analysis procedure is repeated for all damage tolerant SSIs.

y. Tasks from AD, ED, FD, and other structure analyses are listed in the Scheduled Structural Maintenance (P20).

z. The resulting maintenance requirements for all structure are submitted to the ISC for approval and inclusion in the MRB report proposal.

aa. The structural maintenance portion of the Airworthiness Limitations should be included in a separate document and submitted to the appropriate Regulatory Authority (certification) for approval.

Figure 2-4-4.1. Structural Logic Diagram

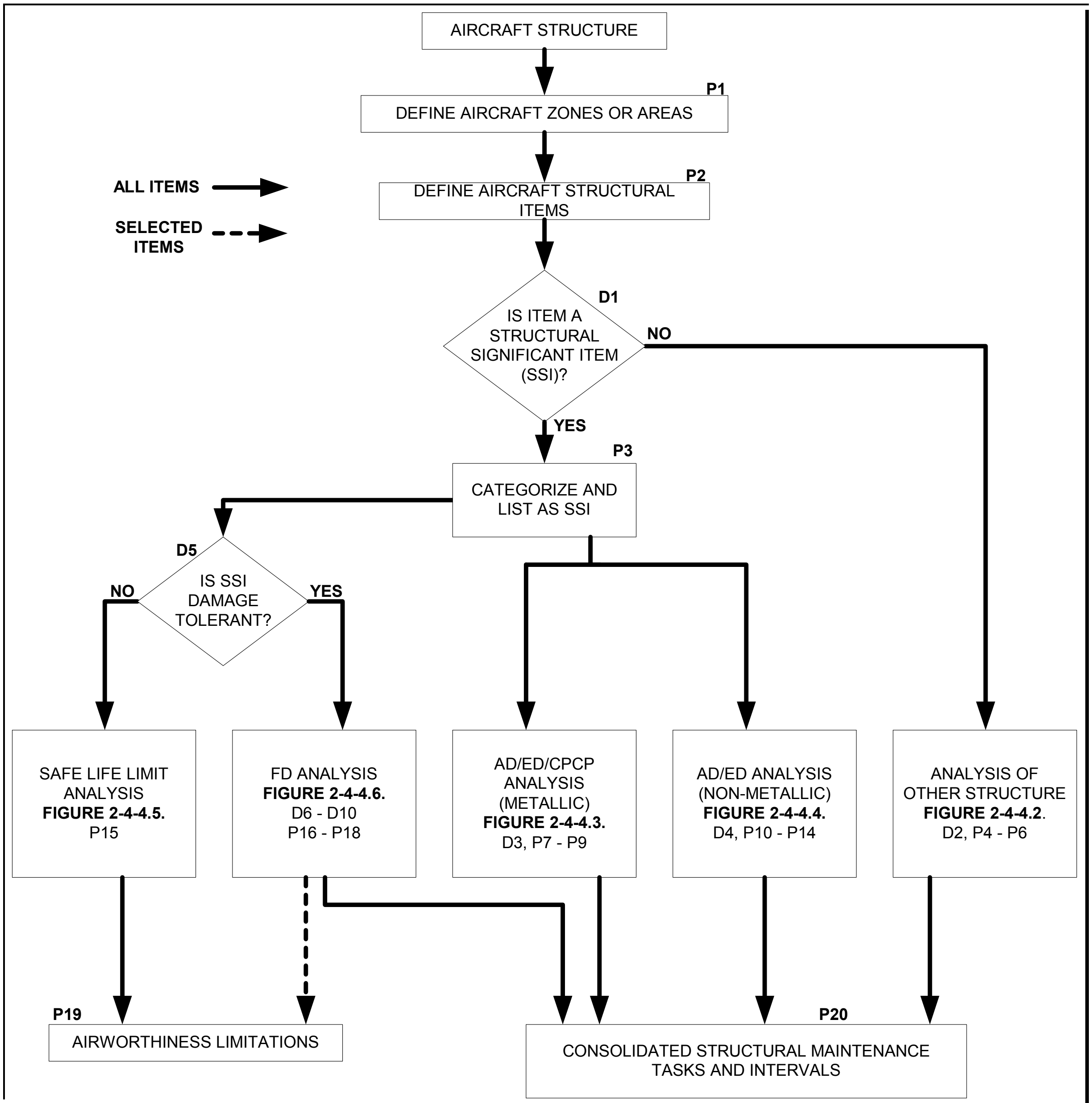


Figure 2-4-4.2. Other Structure Logic Diagram

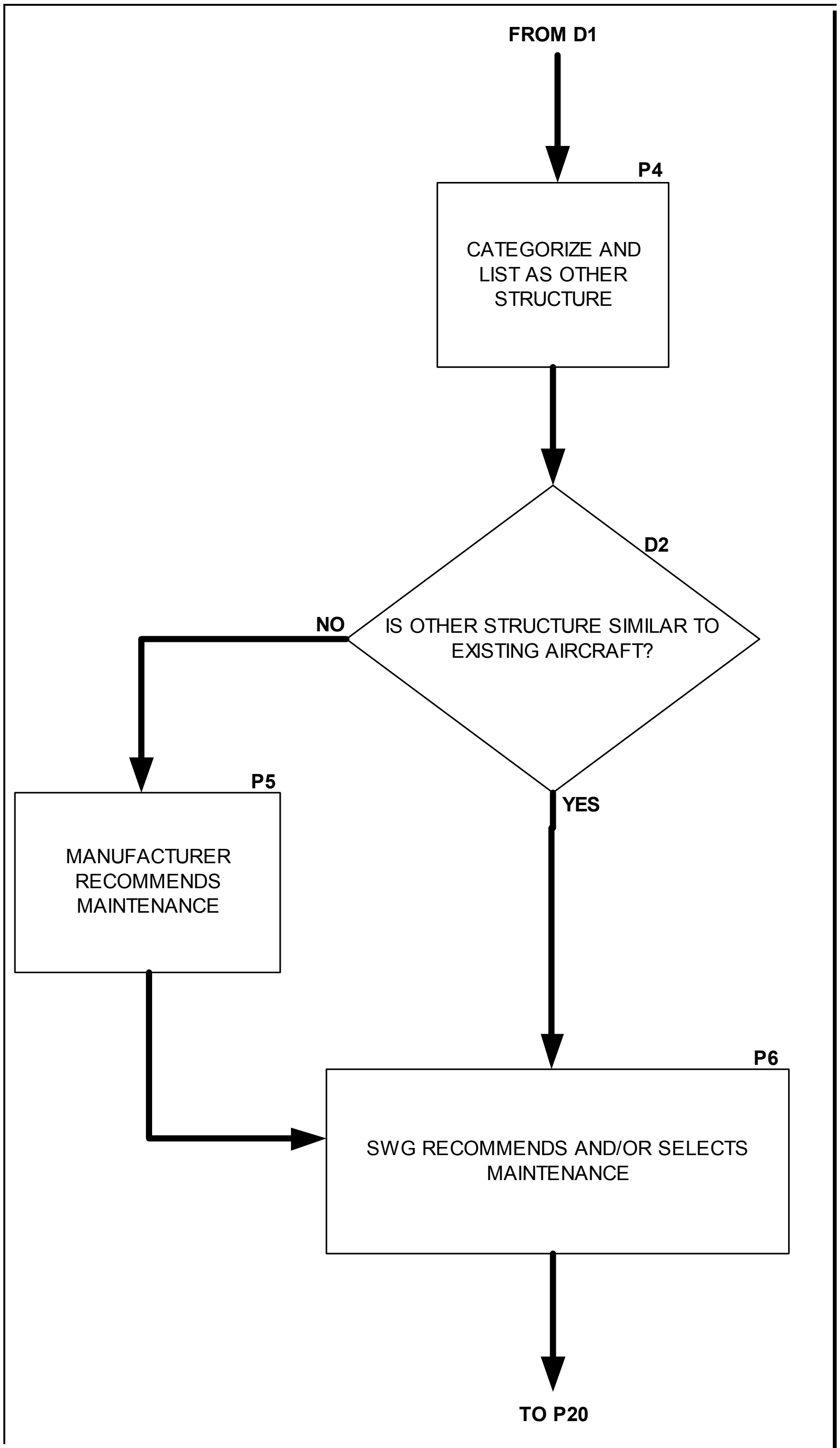


Figure 2-4-4.3. Accidental Damage and Environmental Deterioration (Metallic) Logic Diagram

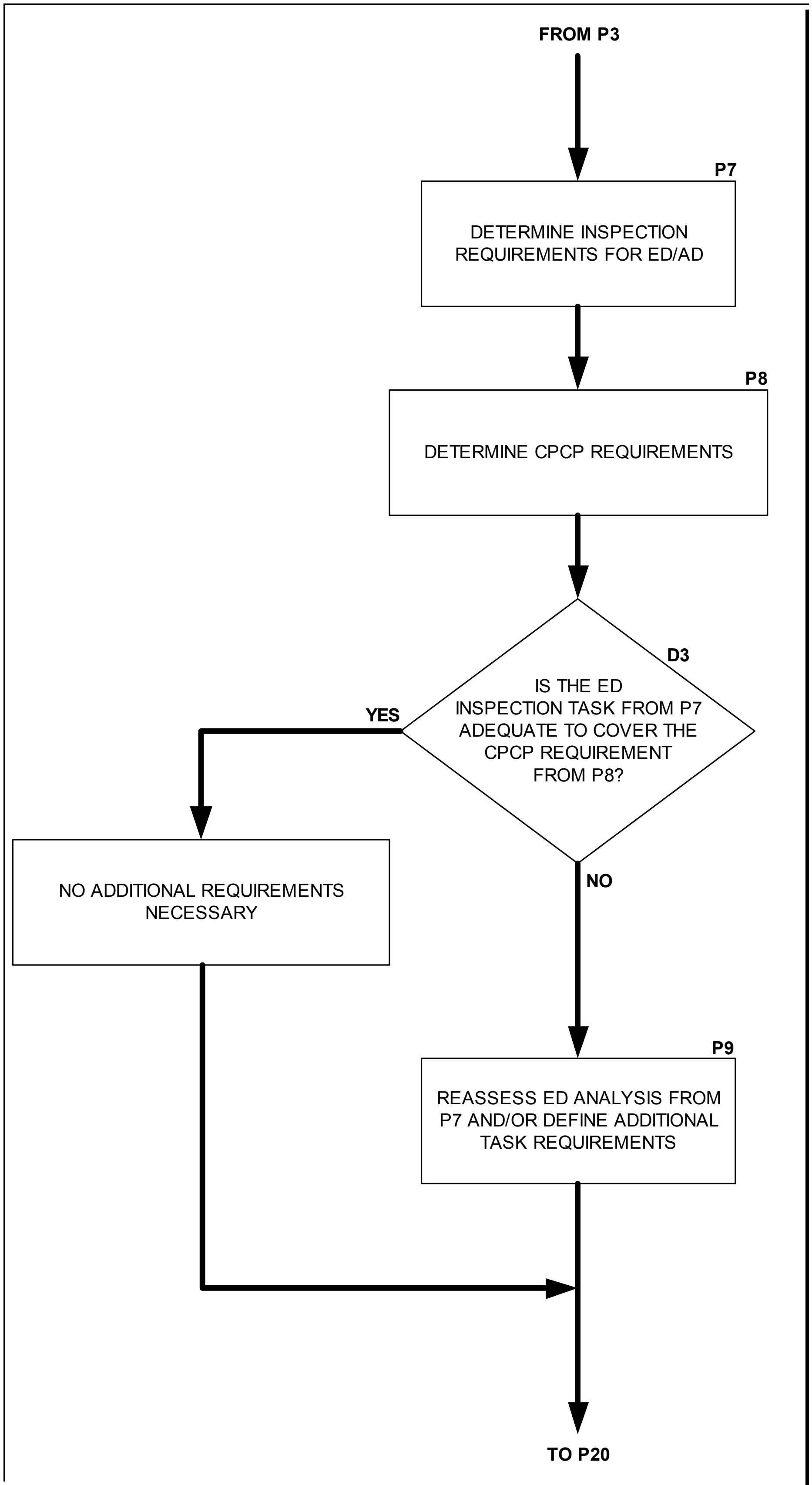

FROM P3
P7
DETERMINE INSPECTION REQUIREMENTS FOR ED/AD
P8
DETERMINE CPCP REQUIREMENTS
D3
IS THE ED INSPECTION TASK FROM P7 ADEQUATE TO COVER THE CPCP REQUIREMENT FROM P8?
YES
NO ADDITIONAL REQUIREMENTS NECESSARY
NO
P9
REASSESS ED ANALYSIS FROM P7 AND/OR DEFINE ADDITIONAL TASK REQUIREMENTS
TO P20

Figure 2-4-4.4. Accidental Damage and Environmental Deterioration (Non-Metallic) Logic Diagram

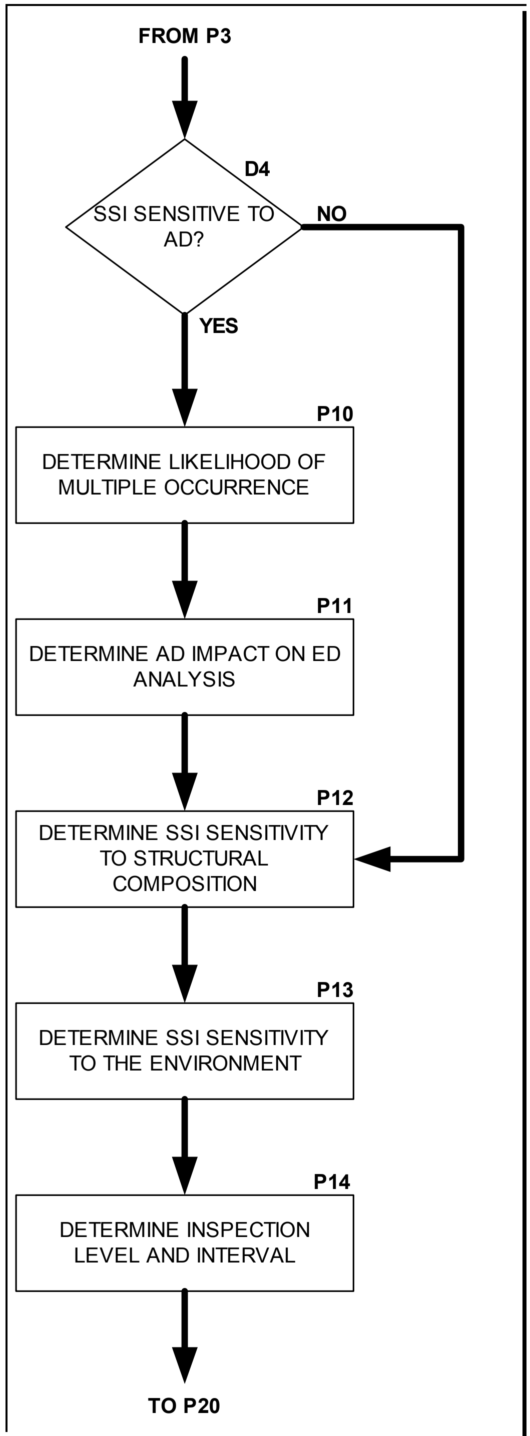


Figure 2-4-4.5. Safelife Limit Analysis Logic Diagram

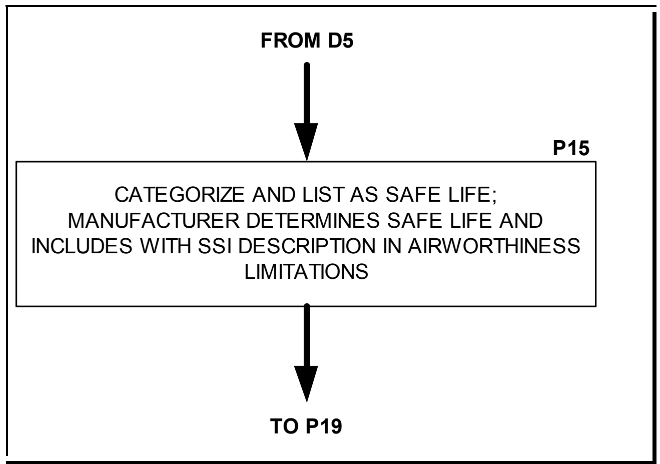
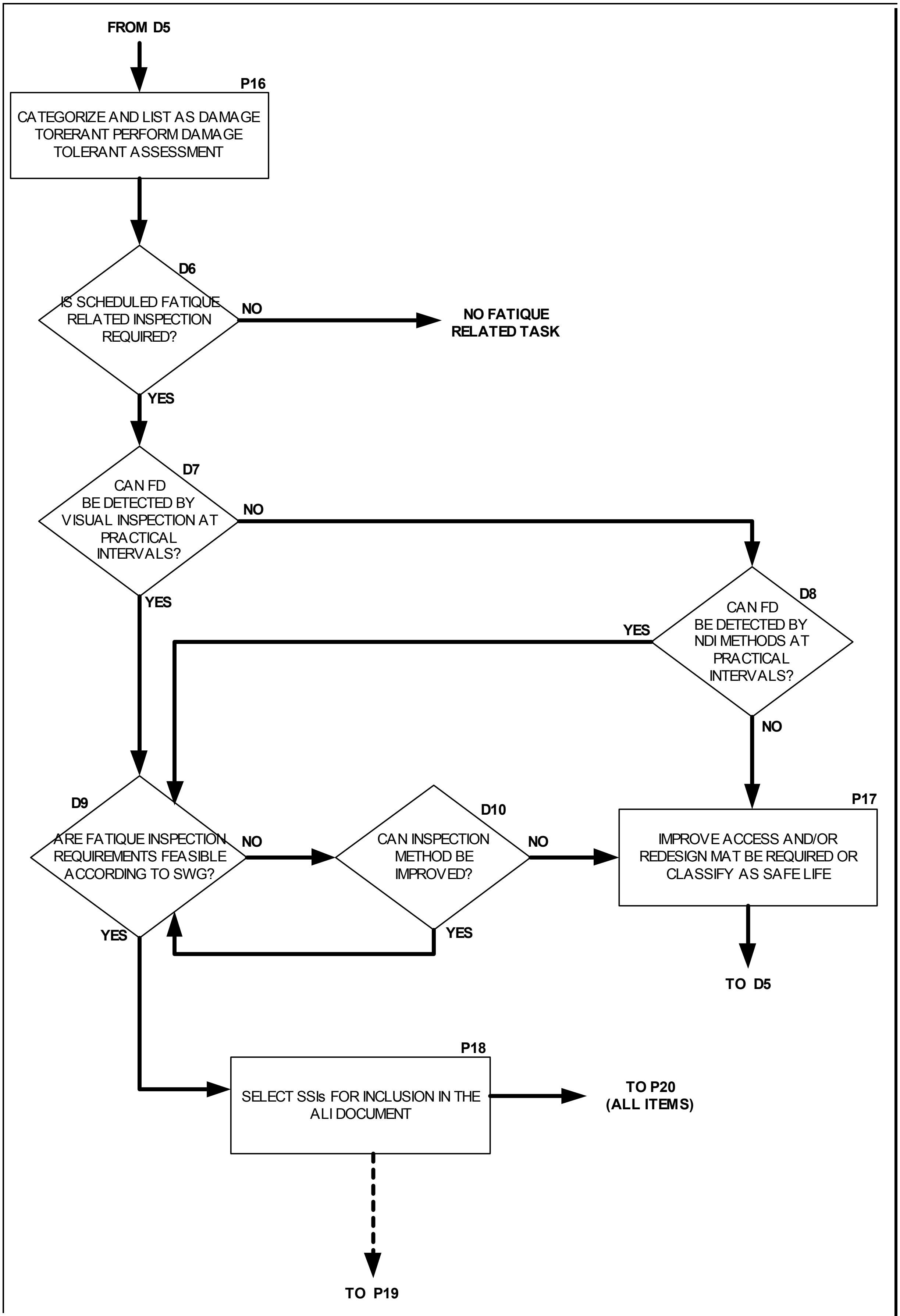


Figure 2-4-4.6. Fatigue Damage Analysis Logic Diagram


FROM D5
P16
CATEGORIZE AND LIST AS DAMAGE TORERANT PERFORM DAMAGE TOLERANT ASSESSMENT
D6
IS SCHEDULED FATIQUE RELATED INSPECTION REQUIRED?
NO
NO FATIQUE RELATED TASK
YES
D7
CAN FD BE DETECTED BY VISUAL INSPECTION AT PRACTICAL INTERVALS?
NO
YES
D8
CAN FD BE DETECTED BY NDI METHODS AT PRACTICAL INTERVALS?
YES
NO
D9
ARE FATIQUE INSPECTION REQUIREMENTS FEASIBLE ACCORDING TO SWG?
NO
YES
D10
CAN INSPECTION METHOD BE IMPROVED?
NO
YES
P17
IMPROVE ACCESS AND/OR REDESIGN MAT BE REQUIRED OR CLASSIFY AS SAFE LIFE
TO D5
P18
SELECT SSIs FOR INCLUSION IN THE ALI DOCUMENT
TO P20 (ALL ITEMS)
TO P19

2-4-5. Rating Systems for Structural Significant Items

As part of the scheduled structural maintenance development, it is necessary to rate each Structural Significant Item in terms of susceptibility (likelihood of damage) and detectability (timely detection of damage). This section provides guidelines to assist manufacturers in the development of suitable rating systems. The rating system should account for the susceptibility of the SSI to the likely source of damage and the likely type of deterioration of the SSI due to the damage source. Differences between metallic and non-metallic portions of the SSI's must be taken into account.

The scheduled structural maintenance tasks and intervals are developed on the basis of requirements to assure timely detection of Accidental Damage, Environmental Deterioration, and Fatigue Damage. Rating systems for AD and ED should be compatible to allow comparative assessments for each group of SSIs. Emphasis is placed on rating each SSI in relation to other SSIs in the same inspection area, leading to increased inspection emphasis for the most critical SSIs. Manufacturer and operator experience is a key ingredient for these evaluations.

Rating systems for FD of metals should incorporate results from the manufacturer's residual strength and crack growth evaluations. Where required, rating systems for FD of non-metals should incorporate results from manufacturer's approved tests. The applicability and effectiveness of various inspection methods, detectable damage sizes and access requirements are key ingredients for these evaluations.

1. Rating Accidental Damage

Accidental damage rating systems should include evaluations of the following

a. Susceptibility to minor (not obvious) accidental damage based on frequency of exposure to and the location of damage from one or more sources, including:

   1. Ground handling equipment
   2. Cargo handling equipment
   3. Those resulting from human error during manufacture, maintenance, and/or operation of the aircraft, that are not included in other damage sources.
   4. Rain, hail, etc.
   5. Runway debris
   6. Lightning strike
   7. Water entrapment

b. Residual strength after accidental damage, normally based on the likely size of damage relative to the critical damage size for the SSI.

c. Timely detection of damage, based on the relative rate of growth after damage is sustained and visibility of the SSI for inspection. Assessments should take into account damage growth associated with non-chemical interaction with an environment, such as disbond or delamination growth associated with a freeze/thaw cycle.

Rating values should be assigned to groups of SSIs in the same inspection area on the basis of comparative assessments within the group.

2. Rating Environmental Deterioration (metals)

Environmental deterioration rating systems should allow for evaluations of susceptibility to and timely detection of corrosion and stress corrosion.

Susceptibility to corrosion is assessed on the basis of probable exposure to an adverse environment and adequacy of the protective system. For example:

a. Exposure to a deteriorating environment such as cabin condensation, galley spillage, toilet spillage, cleaning fluids, etc.

b. Contact between dissimilar materials (potential for galvanic activity).

c. Breakdown of surface protection systems; for example, deterioration of paint, primer, bonding, sealant, corrosion inhibiting compounds and cladding systems with the resulting corrosion of metallic materials or fluid incursion into permeable non-metallic materials, etc.

Material characteristics, coupled with the likelihood of sustained tensile stress, are used to assess susceptibility to stress corrosion.

Timely detection is determined by sensitivity to relative size of damage and visibility of the SSI for inspection.

NOTE:	Rating system evaluations should be made taking into account the requirement for each operator to control the aircraft structure at corrosion Level 1 or better.

3. Rating Environmental Deterioration (non-metals)

Environmental deterioration rating systems should allow for evaluations of susceptibility to, and timely detection of, structural deterioration (e.g., delamination and disbonding).

Susceptibility to deterioration (e.g., loss of stiffness) is assessed on the basis of materials subjected to environmental sources and the adequacy of the protective system. For example:

a. Aramind Fiber Reinforced Plastic (AFRP, also known as Kevlar) is sensitive to Ultra-Violet (UV) light, moisture and other fluids, when directly exposed.

b. Glass Fiber Reinforced Plastic (GFRP) may undergo long term degradation when directly exposed to UV light, but otherwise has low sensitivity to the environment.

c. Carbon Fiber Reinforced Plastic (CFRP) has low sensitivity to the environment.

Susceptibility to delamination and disbonding is assessed on the basis of material type, adequacy of the protective system, and structural composition (e.g., honeycomb and solid laminate), coupled with the likelihood of AD, and exposure to certain environmental conditions.

4. Rating Fatigue Damage

The rating system must lead to inspections that provides a high probability of detecting fatigue damage in the fleet before such damage reduces any aircraft's residual strength below allowable levels. To achieve this, the rating system should consider the following:

a. Residual strength, including the effects of multiple site fatigue damage, where appropriate.

b. Crack growth rate, including effects of multiple site or multiple element fatigue damage, where appropriate.

c. Damage detection period which corresponds to the interval for the fatigue damage to grow from the threshold of detection (detectable) to the limiting size defined by "a" (critical). This period will vary according to the inspection method used, and may be influenced by structural parts or processes, e.g., sealant obscuring parts of the damage.

d. Detection standards for applicable inspection methods.

NOTE:	Estimated detectable crack lengths can be used for the fatigue damage detection evaluations required as part of aircraft type certification.

e. Applicable inspection levels and methods (e.g., visual, NDI), directions (e.g., external, internal) and repeat intervals (e.g., C, 2C, 4C).

2-5. Zonal Analysis Procedure

Zonal inspections may be developed from application of the Zonal Analysis Procedure. This requires a summary review of each zone on the aircraft and normally occurs as the MSG-3 analyses of structures, systems, and powerplants are being concluded. These inspections may subsequently be included in the Zonal Inspections.

This Zonal Analysis Procedure permits appropriate attention to be given to electrical wiring installations. Thus, as well as determining zonal inspections, the logic provides a means to identify applicable and effective tasks to minimize contamination and to address significant wiring installation discrepancies that may not be reliably detected through zonal inspection. These dedicated tasks may subsequently be included in the Systems and Powerplant tasks.

In top down analyses conducted under MSG-3, many support items such as plumbing, ducting, Other Structure, wiring, etc., may be evaluated for possible contribution to functional failure. In cases where a general visual inspection is required to assess degradation, the zonal inspection is an appropriate method.

2-5-1. Procedure

The following procedures may be used

a. Divide the aircraft externally and internally into zones as defined in [ATA iSpec 2200], (formerly ATA Spec 100).

b. For each zone, prepare a work sheet that identifies data such as: zone location and access, approximate size (volume), type of systems and components installed, typical power levels in any wiring bundles, features specific to L/HIRF protection, etc. In addition, assess potential for the presence of combustible material, either through contamination (e.g., dust and lint) or occurring by design (e.g., fuel vapor).

c. Develop rating tables to determine the repeat interval for a zonal inspection. Rating tables will permit the likelihood of accidental damage, environmental deterioration and the density of equipment in the zone to be taken into account.

d. For all zones containing systems installations, perform a standard zonal analysis using the rating tables from paragraph (c.) to define the extent and interval of zonal inspection tasks. Multiple zonal inspections may be identified for each zone with those having less frequent intervals requiring increased access requirements.

e. Identify zones that both contain electrical wiring and have potential for combustible material being present. For those zones, perform an enhanced zonal analysis that permits the identification of stand-alone inspections and tasks that minimize contamination by combustible materials. Rating tables addressing the potential effects of fire on adjacent wiring and systems, the size of the zone and the density of installed equipment may be used to determine the inspection level. General Visual Inspections may be found effective for the complete zone. Detailed Inspections may be found effective for specific items in a zone. Interval determination may be accomplished using rating tables that consider accidental damage and environment.

f. Detailed Inspections and tasks to minimize contamination should be included in the Systems and Powerplant tasks. Since these are not system specific and do not have a Failure Effect

Category, introduction in a dedicated section is suggested, for example, under ATA 20.

g. General Visual Inspections arising from the enhanced zonal analysis (paragraph e.) may be compared with the Zonal Inspections determined from the standard zonal analysis (paragraph d.). The former may be considered fully covered by the zonal inspection if the access requirement is the same and the proposed interval is at least as frequent. Otherwise, a stand-alone GVI should be included with the tasks identified in paragraph (f.).

h. General Visual Inspections arising from the systems, powerplants and structures may be compared with the Zonal Inspections determined from the standard zonal analysis (paragraph d.). Work sheets should record the interval proposed in the originating analysis. These GVIs may be considered fully covered by the zonal inspection if the access requirement is the same and the proposed interval is at least as frequent. Otherwise, a stand-alone GVI should be included within the MSI or SSI from which it was identified.

i. General Visual Inspections arising from the analysis of L/HIRF may be compared with the Zonal Inspections determined from the standard zonal analysis (paragraph d.). These GVIs may be considered fully covered by the zonal inspection if the access requirement is the same and the proposed interval is at least as frequent. Otherwise, a stand-alone GVI should be included within the Systems and Powerplants tasks as described in [Subject 2-6-1].

j. Visual Checks may be considered covered by the Zonal Inspections provided that the Systems Working Group that identified them consider that the failure would be noted and addressed during a zonal inspection. Otherwise, the task should remain in the Systems and Powerplants tasks where specific attention can be drawn to the item.

k. All tasks developed through application of the standard zonal analysis (paragraph d.) should be included in the Zonal Inspections. For accountability purposes, any General Visual Inspection or Visual Check originating from application of systems, powerplant or structures analyses should be referenced in the MRB Report zonal task. To avoid giving unjustified attention to these items, this should not be indicated on task/work cards.

A typical logic diagram is depicted in [Figure 2-5-1.1] and [Figure 2-5-1.2]. This is provided as a guide and may be customized to reflect individual company policies and procedures.

Figure 2-5-1.1. Typical Zonal Analysis Procedure

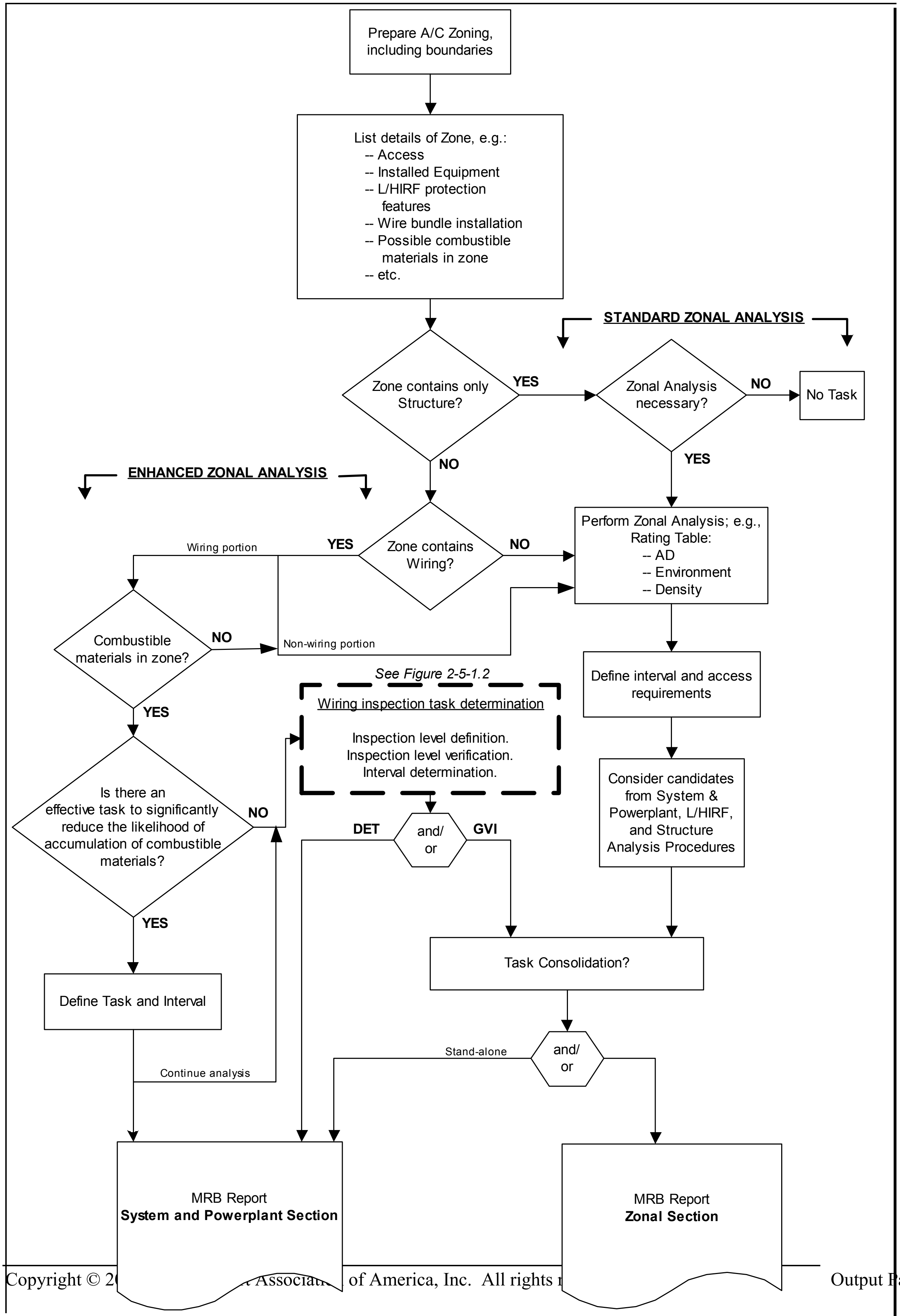
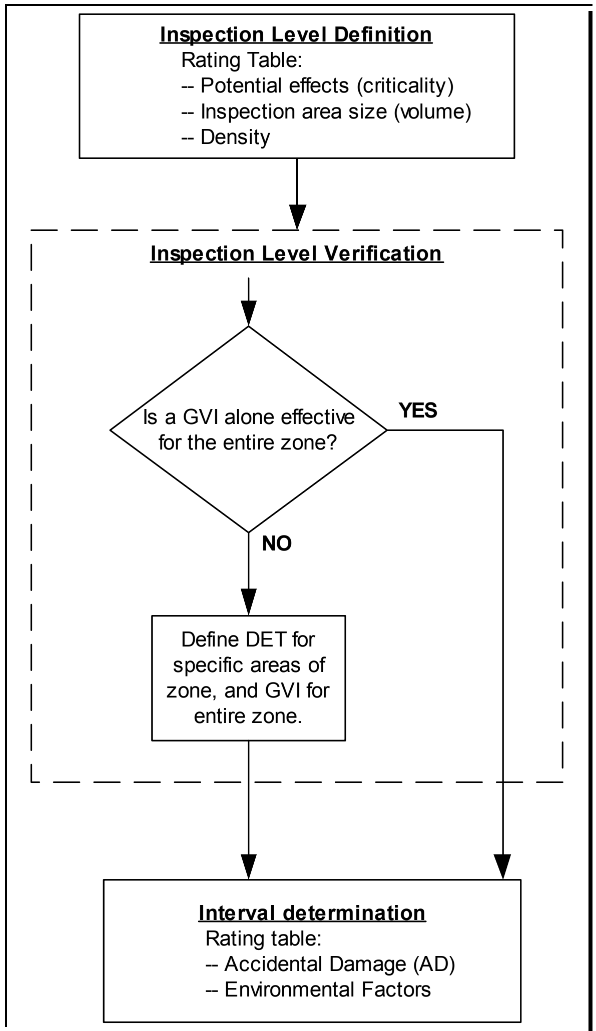

Prepare A/C Zoning, including boundaries
List details of Zone, e.g.:
-- Access
-- Installed Equipment
-- L/HIRF protection features
-- Wire bundle installation
-- Possible combustible materials in zone
-- etc.
STANDARD ZONAL ANALYSIS
Zone contains only Structure?
YES
Zonal Analysis necessary?
NO
No Task
YES
NO
ENHANCED ZONAL ANALYSIS
Wiring portion
YES
Zone contains Wiring?
NO
Perform Zonal Analysis; e.g., Rating Table:
-- AD
-- Environment
-- Density
Combustible materials in zone?
NO
Non-wiring portion
Define interval and access requirements
See Figure 2-5-1.2
Wiring inspection task determination
Inspection level definition.
Inspection level verification.
Interval determination.
YES
Consider candidates from System & Powerplant, L/HIRF, and Structure Analysis Procedures
Is there an effective task to significantly reduce the likelihood of accumulation of combustible materials?
NO
DET
and/ or
GVI
YES
Task Consolidation?
Define Task and Interval
Stand-alone
and/ or
Continue analysis
MRB Report
System and Powerplant Section
MRB Report
Zonal Section

Figure 2-5-1.2. Wiring Inspection Task Determination



2-5-2. Zonal Inspection Task Intervals

Accomplishment intervals are based on hardware susceptibility to damage, the amount of activity in the zone, and operator and manufacturer experience with similar systems, powerplants and structures. When possible, intervals should correspond to those selected for targeted scheduled maintenance checks.

For a given zone, more than one task may be identified. In this case, the frequency of inspection is inversely proportional to the amount of access required; i.e., the more access required, the less the frequency of inspection.

2-6. Lightning/High Intensity Radiated Field (L/HIRF) Analysis Procedure

Lightning/High Intensity Radiated Field (L/HIRF) protection systems have been identified for development of dedicated maintenance. The intent of this maintenance is to reduce the possibility that a single failure cause (such as a lightning strike), and the occurrence of a common failure cause (such as ED or AD) across redundant channels of L/HIRF protection, could impact aircraft airworthiness.

This section contains guidelines for development of scheduled maintenance tasks for aircraft L/HIRF protection systems. Each L/HIRF protective system item is evaluated in terms of its susceptibility to degradation from environmental deterioration and/or accidental damage. The L/HIRF protection system maintenance tasks are developed in support of the aircraft type certification and MRB report development.

Using a logic type analysis, the Working Group determines the type of scheduled maintenance task that is both applicable and effective along with the frequency (interval) of the task.

Lightning/High Intensity Radiated Field (L/HIRF) protection is rated for its criticality with respect to the consequences of the protection's failure.

L/HIRF maintenance is divided into two (2) distinct categories:

1. <u>L/HIRF Protection within LRUs (contained in the Component Maintenance Manual, CMM).</u>
   L/HIRF protection features are incorporated inside the LRU. Protection devices such as filter pin connectors, discrete filter capacitors and transient protection devices (tranzorbs) are installed within LRUs on one or more of the LRU interface circuits.

   The aircraft manufacturer will work with the suppliers of LRUs requiring L/HIRF protection to ensure that the CMM states the Supplier's maintenance philosophy to ensure the continued effectiveness of L/HIRF protective devices. The maintenance of this type of L/HIRF protection is not developed with the use of this document.

2. <u>L/HIRF Protection on the aircraft (developed during this MSG-3 process, and contained isn the subsequent MRB Report).</u>
   All Level A and B L/HIRF protection on the aircraft (any protection not within an LRU) that was identified during L/HIRF certification must be analyzed. Normally this includes items such as shielded wires, raceways, bonding jumpers, connectors, composite fairings with conductive mesh, and the inherent conductivity of the structure, but may include aircraft specific devices, e.g., RF Gaskets.

   Level A systems are electrical and electronic systems whose failure would cause or contribute to a failure of function resulting in a catastrophic-failure condition of the aircraft.

   Level B systems are electrical and electronic systems whose failure would cause or contribute to a failure of function resulting in a hazardous-failure condition of the aircraft.

2-6-1. L/HIRF Maintenance

The scheduled maintenance must cover all identified L/HIRF protection. The majority of this protection will be covered through the Zonal Inspections. Where this Zonal maintenance will not adequately identify degradation of the L/HIRF protection, additional scheduled maintenance may be generated.

1. L/HIRF Protection Analysis Focus

In order to narrow the focus of the analysis, the following concepts are accepted:

1. All visible L/HIRF protection (wires, shields, connectors, bonding straps, or raceways between connectors or termination points) may be covered by the Zonal Inspections.
2. L/HIRF protection within conduit or heatshrink, is covered in the Zonal Inspections by confirming integrity of the protective covering.
3. Inherent conductivity of the aircraft structure is covered by the Zonal Inspections. Corrosion concerns are addressed by the Structural Inspections.
4. Composite fairings with conductive mesh are covered by the Zonal Inspections.
5. Where the Zonal Inspections are not effective, additional analysis may produce other scheduled maintenance tasks.

2. L/HIRF Protection Analysis Ratings

L/HIRF protections require an analysis for the effects of Environmental Deterioration (ED) and Accidental Damage (AD) to determine what maintenance will effectively detect degradation.

<u>Environment</u> - consider the effects of the atmosphere, corrosive products, condensation, temperature, and vibration on the protection, with respect to degradation.

<u>Susceptibility to Damage</u> - consider the likelihood of damage during maintenance or damage during operations. Examples would be areas where connectors could be stepped on, or effects of de-icing fluid on a connector during winter operations.

3. Analysis Approval

Once the analysis is completed, the resulting maintenance tasks and intervals for all L/HIRF systems are submitted to the ISC for approval and inclusion in the MRB Report proposal.

4. Flowchart Description

The following is the intent of each block of the flow chart that follows:

Block 1 - "Aircraft L/HIRF Protective Systems"
Self-explanatory; flow diagram "Title" block.

Block 2 - "Define Aircraft Zones"
Prior to accomplishment of L/HIRF analysis, it is necessary to have the Zones defined.

Block 3 - "Define Level A and B"
Defining what systems are Level A or Level B is a separate process from MSG-3, and is usually derived from a separate engineering report

Block 4 - Is it a Level A or B?"
Analysis for Level A will follow a separate flow path from Level B.

Block 5 - "Determine Inspection"
L/HIRF analysis will use an ED/AD assessment to determine task and interval for L/HIRF protection maintenance.

Block 6 - "Are Zonal Inspection Tasks Applicable and Effective?"
Wherever possible, credit will be taken for Zonal Inspections.

Block 7 - "Covered by Zonal Maintenance"
Assessment shows the Zonal Inspections are effective.

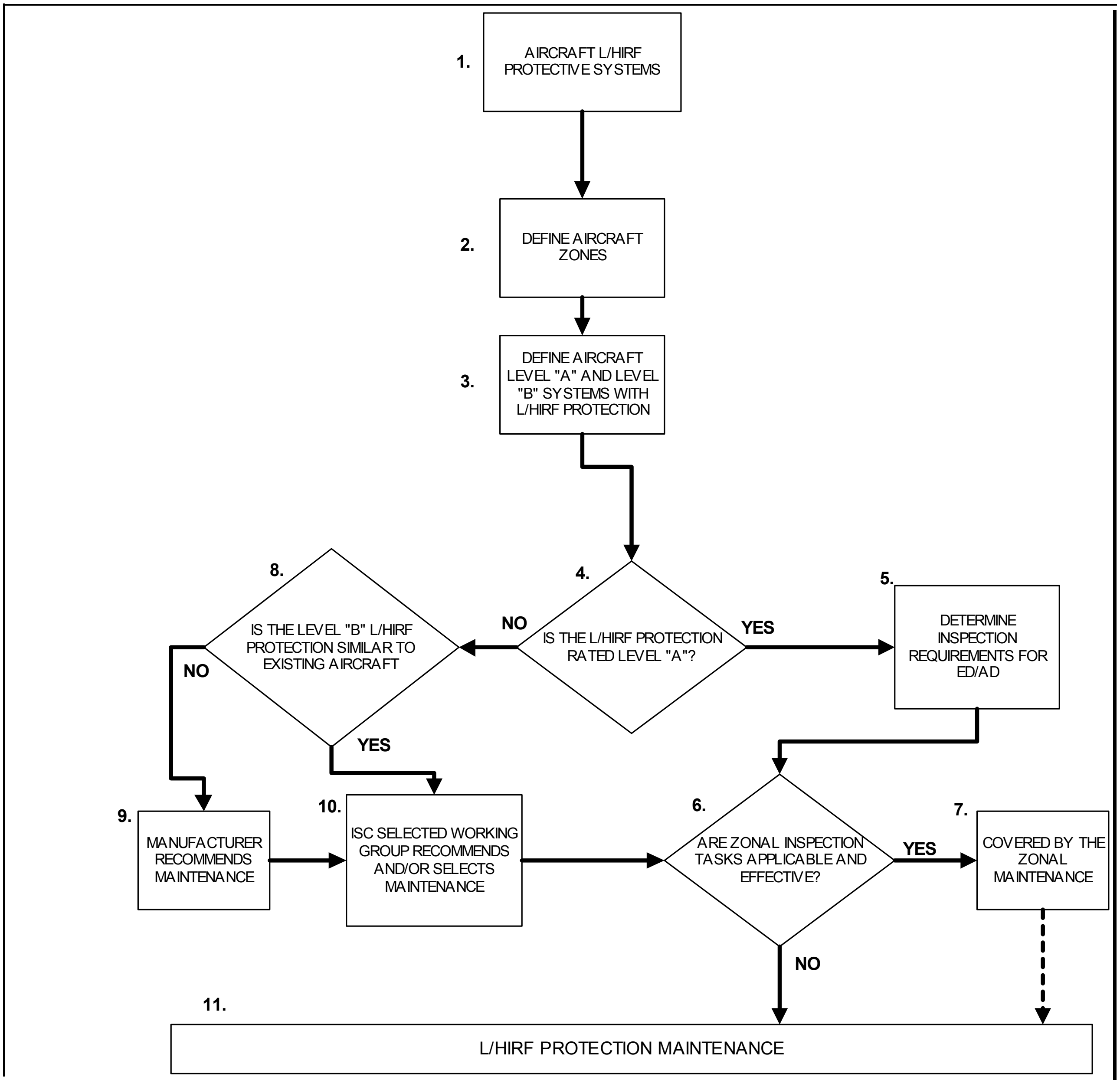
Block 8 - "Is Protection Similar?"
Is it possible to take credit for similar protection that has been evaluated to be effective on similar type aircraft?

Block 9 - "Manufacturer's Maintenance"
If there is no similar protection installed on another aircraft, the manufacturer can choose it's own method for task determination on Level B systems.

Block 10 - Working Group Recommendations"
Incorporation of the Working Group's recommendations.

Block 11 - "L/HIRF Maintenance"
All tasks roll into the L/HIRF Maintenance.

Figure 2-6-2.1. L/HIRF Logic Diagram



Appendix A. Glossary

Accidental Damage (AD)	Physical deterioration of an item caused by contact or impact with an object or influence which is not a part of the aircraft, or by human error during manufacturing, operation of the aircraft, or maintenance practices.
Age Exploration	A systematic evaluation of an item based on analysis of collected information from in-service experience. It verifies the item's resistance to a deterioration process with respect to increasing age.
Airworthiness Limitations	A section of the Instructions for Continued Airworthiness that contains each mandatory replacement time, structural inspection interval, and related structural inspection task. This section may also be used to define a threshold for the fatigue related inspections and the need to control corrosion to Level 1 or better. The information contained in the Airworthiness Limitations section may be changed to reflect service and/or test experience or new analysis methods.
Conditional Probability of Failure	The probability that a failure will occur in a specific period provided that the item concerned has survived to the beginning of that period.
Corrosion Level 1	Corrosion damage that does not require structural reinforcement or replacement. or Corrosion occurring between successive inspections exceeds allowable limit but is local and can be attributed to an event not typical of operator usage of other aircraft in the same fleet (e.g. Mercury spill).
Corrosion Prevention and Control Program (CPCP)	A program of maintenance tasks implemented at a threshold designed to control an aircraft structure to Corrosion Level 1 or better.
Damage Tolerant	A qualification standard for aircraft structure. An item is judged to be damage tolerant if it can sustain damage and the remaining structure can withstand reasonable loads without structural failure or excessive structural deformation until the damage is detected.
Delamination/Disbond	Structural separation or cracking that occurs at or in the bond plane of a structural element, within a structural assembly, caused by in service accidental damage, environmental effects and/or cyclic loading.
Discard	The removal from service of an item at a specified life limit.
Direct Adverse Effect on Operating Safety	

Direct	To be direct, the functional failure or resulting secondary damage must achieve its effect by itself, not in combination with other functional failures (no redundancy exists and it is a primary dispatch item).
Adverse Effect on Safety	Safety shall be considered as adversely affected if the consequences of the failure condition would prevent the continued safe flight and landing of the aircraft and/or might cause serious or fatal injury to human occupants.
Operating	This is defined as the time interval during which passengers and crew are on board for the purpose of flight.
Economic Effects	Failure effects which do not prevent aircraft operation, but are economically undesirable due to added labor and material cost for aircraft or shop repair.
Environmental Deterioration (ED)	Physical deterioration of an item's strength or resistance to failure as a result of chemical interaction with its climate or environment.
Failure	The inability of an item to perform within previously specified limits.
Failure Cause	Why the functional failure occurs.
Failure Condition	The effect on the aircraft and its occupants, both direct and consequential, caused or contributed to by one or more failures, considering relevant adverse operational or environmental conditions.
Failure Effect	What is the result of a functional failure.
Fatigue Damage (FD)	The initiation of a crack or cracks due to cyclic loading and subsequent propagation.
Fatigue Related Sampling Inspection	Inspections on specific aircraft selected from those which have the highest operating age/usage in order to identify the first evidence of deterioration in their condition caused by fatigue damage.
Fault	An identifiable condition in which one element of a redundant system has failed (no longer available) without impact on the required function output of the system (MSI). At the system level, a fault is not considered a functional failure.
Fault-Tolerant System	A system that is designed with redundant elements that can fail without impact on safety or operating capability.
Function	The normal characteristic actions of an item.
Functional Check	A quantitative check to determine if one or more functions of an item performs within specified limits.
Functional Failure	Failure of an item to perform its intended function within specified limits.

Hidden Function	1. A function which is normally active and whose cessation will not be evident to the operating crew during performance of normal duties. 2. A function which is normally inactive and whose readiness to perform, prior to it being needed, will not be evident to the operating crew during performance of normal duties.
Inherent Level of Reliability and Safety	That level which is built into the unit and, therefore, inherent in its design. This is the highest level of reliability and safety that can be expected from a unit, system, or aircraft if it receives effective maintenance To achieve higher levels of reliability generally requires modification or redesign.
Inspection - Detailed (DET)	An intensive examination of a specific item, installation or assembly to detect damage, failure or irregularity. Available lighting is normally supplemented with a direct source of good lighting at an intensity deemed appropriate. Inspection aids such as mirrors, magnifying lenses, etc. may be necessary. Surface cleaning and elaborate access procedures may be required.
Inspection - General Visual (GVI)	A visual examination of an interior or exterior area, installation or assembly to detect obvious damage, failure or irregularity. This level of inspection is made from within touching distance unless otherwise specified. A mirror may be necessary to enhance visual access to all exposed surfaces in the inspection area. This level of inspection is made under normally available lighting conditions such as daylight, hangar lighting, flashlight or drop-light and may require removal or opening of access panels or doors. Stands, ladders or platforms may be required to gain proximity to the area being checked.
Inspection - Special Detailed (SDI)	An intensive examination of a specific item, installation, or assembly to detect damage, failure or irregularity. The examination is likely to make extensive use of specialized Inspection Techniques and/or equipment. Intricate cleaning and substantial access or disassembly procedure may be required.
Inspection - Zonal	A collective term comprising selected general visual inspections and visual checks that is applied to each zone, defined by access and area, to check system and powerplant installations and structure for security and general condition.
Interval (Initial - Repeat)	<u>Initial Interval</u> - Interval between the start of service-life and the first task accomplishment <u>Repeat Interval</u> - The interval (after the initial interval) between successive accomplishments of a specific maintenance task.
Item	Any level of hardware assembly (i.e., system, sub-system, module, accessory, component, unit, part, etc.).
Letter Checks	Letter checks are named collections of tasks (e.g., A-

	Check, C-Check, etc.) assigned the same interval.
Lubrication and Servicing	Any act of lubricating or servicing for the purpose of maintaining inherent design capabilities.
Maintenance Significant Item - (MSI)	Items identified by the manufacturer whose failure a. could affect safety (on ground or in flight), and/or b. is undetectable during operations, and/or c. could have significant operational impact, and/or d. could have significant economic impact
Multiple Element Fatigue Damage	The simultaneous cracking of multiple load path discrete elements working at similar stress levels.
Multiple Site Fatigue Damage	The presence of a number of adjacent, small cracks that might coalesce to form a single long crack.
Non-metallics	Any structural material made from fibrous or laminated components bonded together by a medium. Materials such as graphite epoxy, boron epoxy, fiber glass, kevlar epoxy, acrylics and the like are non-metallics. Non-metallics include adhesives used to join other metallic or non-metallic structural materials.
Operating Crew Normal Duties	
Operating Crew	Qualified flight compartment and cabin attendant personnel who are on duty.
Normal Duties	Those duties associated with the routine operation of the aircraft, on a daily basis, to include the following: a. Procedures and checks performed during aircraft operation in accordance with the Aircraft Flight Manual. b. Recognition of abnormalities or failures by the operating crew through the use of normal physical senses (e.g., odor, noise, vibration, temperature, visual observation of damage or failure, changes in physical input force requirements, etc.).
Operational Check	An operational check is a task to determine that an item is fulfilling its intended purpose. Does not require quantitative tolerances. This is a failure finding task.
Operational Effects	Failure effects which interfere with the completion of the aircraft mission. These failures cause delays, cancelations, ground or flight interruptions, high drag coefficients, altitude restrictions, etc.
Other Structure	Structure which is judged not to be a Structural Significant Item. "Other Structure" is defined both externally and internally within zonal boundaries.
Potential Failure	A defined identifiable condition that indicates that a degradation process is taking place that will lead to a functional failure.
Protective Device	Any device or system that has a function to avoid,

	eliminate or reduce the consequences of an event or the failure of some other function.
P to F Interval	Interval between the point at which a potential failure becomes detectable and the point at which it degrades into a functional failure.
Redundant Functional Elements	Two or more independent physical elements of a system/item providing the same function.
Residual Strength	The strength of a damaged structure.
Restoration	That work necessary to return the item to a specific standard. Restoration may vary from cleaning or replacement of single parts up to a complete overhaul.
Safe Life Structure	Structure which is not practical to design or qualify as damage tolerant. Its reliability is protected by discard limits which remove items from service before fatigue cracking is expected.
Safety (adverse effect)	Safety shall be considered as adversely affected if the consequences of the failure condition would prevent the continued safe flight and landing of the aircraft and/or might cause serious or fatal injury to human occupants.
Safety/Emergency Systems or Equipment	A device or system that: 1) enhances the evacuation of the aircraft in an emergency or, 2) if it does not function when required, results in a Failure Condition that might have an adverse effect on safety.
Scheduled Maintenance Check	Any of the maintenance opportunities which are prepackaged and are accomplished on a regular basis.
Structural Significant Item - (SSI)	Any detail, element or assembly, which contributes significantly to carrying flight, ground, pressure or control loads and whose failure could affect the structural integrity necessary for the safety of the aircraft.
Structural Assembly	One or more structural elements which together provide a basic structural function.
Structural Detail	The lowest functional level in an aircraft structure. A discrete region or area of a structural element, or a boundary intersection of two or more elements.
Structural Element	Two or more structural details which together form an identified manufacturer's assembly part.
Structural Function	The mode of action of aircraft structure. It includes acceptance and transfer of specified loads in items (details /elements /assemblies) and provides consistently adequate aircraft response and flight characteristics.

Task Applicability	A set of conditions that leads to the identification of a task type when a specific set of characteristics of the failure cause being analyzed would be discovered and/or corrected as a result of the task being accomplished.
Task Effectiveness	A specific set of conditions that leads to the selection of a task already identified to be applicable. Avoids, eliminates, or reduces the negative consequences of the failure to an extent that justifies doing the task at the selected interval.
Tasks - Maintenance	An action or set of actions required to achieve a desired outcome which restores an item to or maintains an item in serviceable condition, including inspection and determination of condition.
Threshold	See "Interval - Initial".
Threshold Period	A period during which no occurrences of the failure can reasonably be expected to occur after the item enters into service.
Visual Check	A visual check is an observation to determine that an item is fulfilling its intended purpose. Does not require quantitative tolerances. This is a failure finding task.

Annex 1. References

ATA Specification 2200. Information Standards for Aviation Maintenance. Air Transport Association (www.airlines.org), Washington, DC.

